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BUILDING FOR AN INTERMODAL FUTURE

The North-South Rail Link

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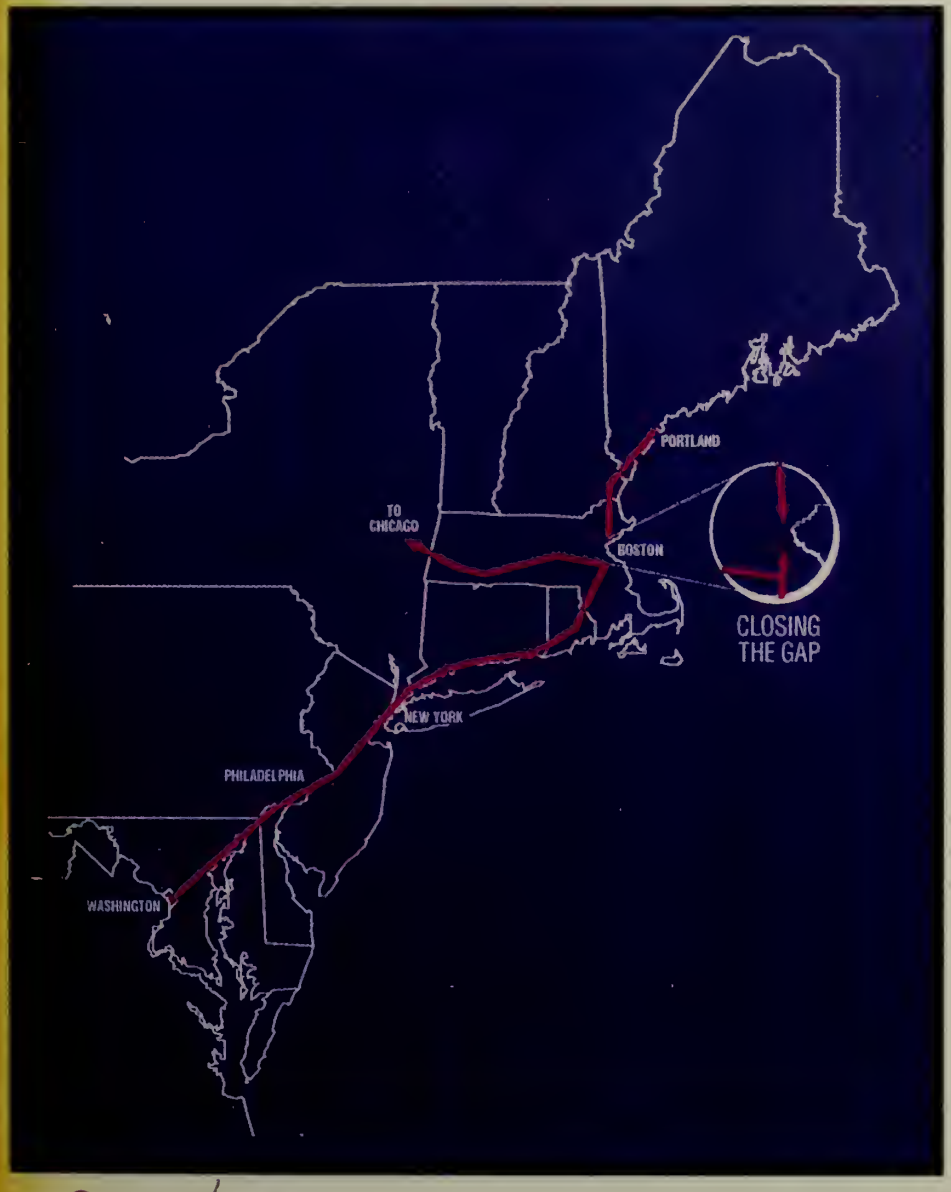
Central Artery Rail Link
Task Force
Final Report
May 1993



William F. Weld
Governor

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James J. Kerasiotes
Secretary

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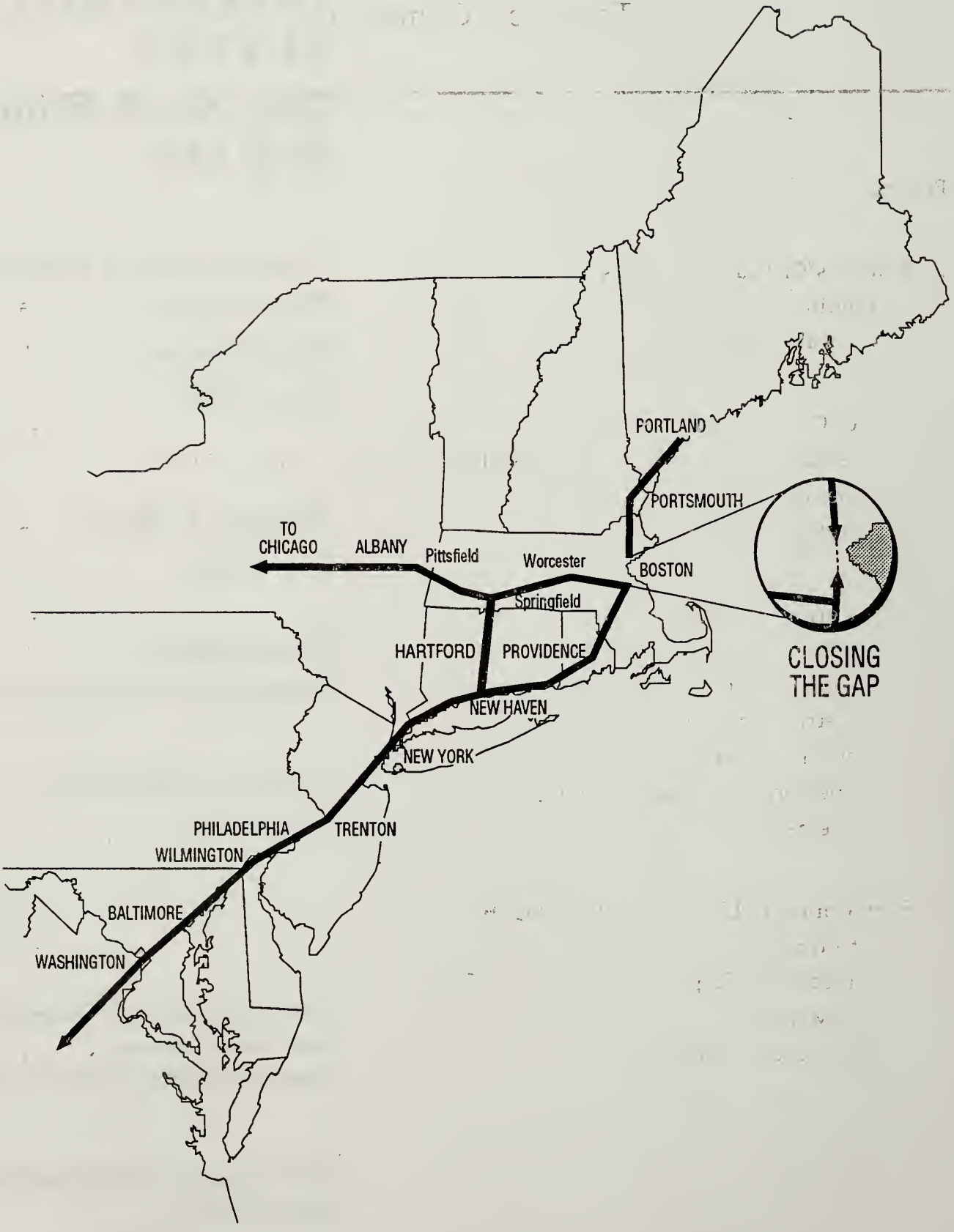
State Transportation Building
10 Park Plaza
Boston, MA 02116

Completing the Northeast Corridor



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Acknowledgements

Numerous individuals from many organizations contributed significantly to this effort in both technical and administrative capacities. The lead agencies of the Task Force were the Massachusetts Executive Office of Transportation and Construction, The Massachusetts Highway Department, the Massachusetts Bay Transportation Authority, and the Central Transportation Planning Staff. The principal source of technical support was the Central Artery Project Design Team.

Valuable technical contributions to this effort were made by the National Rail Passenger Corporation (Amtrak), and the firms of STV/Seelye Stevenson Value & Knecht and KPMG Peat Marwick, working under contract to the Federal Transit Administration.

Preface

BACKGROUND

Generations of New England leaders have recognized the benefits of connecting Boston's North and South Stations by rail. But for almost a century, limited transportation vision, technical infeasibility, and financial concerns have held back such an effort. Today, a fortunate confluence of events has put the Rail Link within reach, and the Commonwealth on Massachusetts is moving to take full advantage of this opportunity.

On January 14, 1993, Massachusetts Governor William F. Weld and Lieutenant Governor A. Paul Cellucci announced their commitment to explore the feasibility of a Rail Link. Such a link will:

1. Close the only remaining gap in intercity rail service along the Atlantic seaboard;

2. Develop an integrated regional rail network serving both Massachusetts and New England through improved Massachusetts Bay Transportation Authority commuter rail service;

3. Reaffirm Massachusetts as a national leader in intermodal transportation planning, design, engineering, and construction;

4. Broaden the public benefits of the Central Artery/Tunnel Project through increased regional service, consistent with national transportation and environmental policy.

On February 2, 1993, Massachusetts Secretary of Transportation James J. Kerasiotes, formed the Central Artery Rail Link Task Force to determine the feasibility of constructing a Rail Link between Boston's North and South Stations in conjunction with the Central Artery/Tunnel Project.

The Task Force is an intermodal and interdisciplinary transportation team. Its members consist of senior professionals from the Executive Office of Transportation and Construction, the Massachusetts Highway Department, the Massachusetts Bay Transportation Authority, and the Central Transportation Planning Staff, with support from the Central Artery/Tunnel Project Design Team.

The Federal Transit Administration (FTA) of the U.S. Department of Transportation represented by its technical consultants from the firms KPMG Peat Marwick and STV/Seelye Stevenson Value & Knecht, has been kept fully informed of all the Task Force's deliberations and decisions.

ADDED ENVIRONMENTAL BENEFIT

Massachusetts is striving to comply with the environmental standards established by the Clean Air Act of 1990. The Central Artery/Tunnel Project will play a central role in this strategy, reducing overall carbon monoxide levels in the Boston core by an estimated 12 percent (CA/T F.S.E.I.R., November, 1990).

Today, however, the Commonwealth is in technical violation of the Act, particularly with regard to ozone levels. High ozone levels produce serious health impacts, including impaired breathing, aggravated asthma and bronchitis, and exacerbated heart and lung diseases.

If Massachusetts fails to meet the requirements of the Clean Air Act by 1999, the U. S. Environmental Protection Agency is directed to impose sanctions. These may include, but are not limited to, restrictions on new industrial growth, more stringent requirements for air pollution control, the withholding of federal funds for sewage treatment projects such as the Boston Harbor Cleanup, and the withholding of funds for transportation projects, particularly highway improvements.

Every effort made now by the state transportation sector to reduce air pollution reduces the chance that costly controls on utilities and industry, large and small, will be required in the future. Improved air quality will allow Massachusetts and New England to remain desirable locations for new industry, and provide new opportunities for existing firms to grow.

Construction of the North/South Station Rail Link can be a crucial additional component in Massachusetts' air pollution mitigation strategies. It will maximize intercity and regional rail ridership to the north, south, and west of Boston helping to remove automobiles from the highways.

NATIONAL TRANSPORTATION POLICY

Building the Rail Link now will ensure Massachusetts' position as a national leader in intermodal transportation policy. The Rail Link will provide a reliable, energy-efficient transportation option to serve commuters, intercity travelers, and the numerous tourists who visit Boston's historic and cultural attractions.

National transportation leaders recognize the overwhelming need for a new transportation outlook that promotes economic growth and environmental responsibility. New federal funding options now offer each state increased creativity in transportation planning. These new options are helping to yield new

transportation efficiencies through intermodal planning -- the integration of highway, rail, air, and marine travel.

Reduced automobile congestion in urban areas is a key criterion for intermodal funding policy. Linking automotive travel with other mass transit and ride sharing options has already proven successful in reducing traffic congestion levels. The regional rail system to be created in association with the Rail Link will serve as the most far-reaching element of an integrated regional transit system connecting suburban park-and-ride commuter rail stations to the subway/streetcar rapid transit network, city and regional bus service, and Logan Airport. Building the Rail Link will offer new transportation options by making the overall metropolitan highway and public transportation system more interconnected, efficient, and accessible.

ENERGY IMPERATIVE

Construction of the Rail Link, along with regional rail system electrification, will prove to be a meaningful and significant action to address the energy realities facing the world today. We are now late in the era of petroleum-based economies. Global oil reserves are expected to be depleted in the coming decades. During the first half of the Twenty-First Century, energy users world-wide will be forced to rely increasingly on electric power sources. Higher priced petroleum fuels will necessitate a shift to electric power for our public transportation systems.

Intercity rail passenger systems around the world -- particularly in Europe and Japan -- are already electrified. The intercity and regional electrification proposed with the Rail Link will no doubt be viewed by the following generations as simple economic common sense.

JOINT CONSTRUCTION OPPORTUNITY

The Central Artery/Third Harbor Tunnel project contributes to this intermodal opportunity. It makes it possible to build the Rail Link beneath the highway realizing the economies inherent in a shared corridor, as opposed to a completely independent one.

Without the Central Artery/Tunnel Project, the Rail Link would be much more costly and difficult to build. With the Rail Link, Massachusetts has an opportunity to make a major improvement to New England's transportation system, its environment, and its future economic health. The window of opportunity is brief; it is important that the Commonwealth of Massachusetts take advantage of it by making the Central Artery/Tunnel Project intermodal and consistent with national transportation policy now.

1 Findings/Critical Next Steps

The Task Force has reached a number of findings and identified several critical next steps in implementing the Rail Link.

FINDINGS

- Feasibility. It is feasible to build a two track Rail Link in the Central Artery Corridor with expansion capacity to a total of four tracks.

- Alignment. The preferred Central Artery Rail Link route will start from two southerly tunnel portals, one along Herald Street east of Back Bay Station, the other in the vicinity of the railroad yards south of the West Fourth Street Bridge in South Boston (See Figure 1). North of South Station the Rail Link will be located directly beneath the depressed Central Artery, before moving off to the westerly side of the Artery alignment and passing under the Charles River to north tunnel portals north of the Gilmore Bridge in Somerville.

- Stations. The Rail Link will have three stations, one under the existing South Station, the second near the MBTA Blue Line at State Street, and the third located between Haymarket and North Station. Rail Link stations will provide direct interconnectivity with all lines of the MBTA rapid transit system.

- Motive Power. Because of ventilation and safety requirements, all train operations through the Rail Link tunnel must be electrically powered.

- Amtrak Service. The Rail Link will allow completion of the Northeast Corridor Amtrak intercity rail system with provision of through-routed service from Portland, Maine to Boston, New York, and Washington, D.C. The Rail Link will also provide for the integration of eventual intercity service to Nashua, Manchester, and Concord, New Hampshire.

- Regional Rail Service. The Rail Link will create a unified rail system for metropolitan Boston by combining the two currently separate northside and southside commuter railroad services. Regional rail service will be routed through downtown Boston providing both improved core area trip distribution and metropolitan areawide service interconnectivity.

- Regional Rail Ridership. From a low of approximately 30,000 one-way trips daily during the early 1970's, Boston area commuter railroad ridership has grown to a current level of approximately 70,000 rides a day (35,000 round trip passengers). Currently anticipated rail service extensions combined with future downtown Boston growth are expected to raise this to 120,000 rides daily by the year 2010 without the Rail Link. With the Rail Link and faster electrified regional rail service, the total is expected to rise another 57,000 rides to 177,000 daily. Of the additional daily railroad trips, approximately 23,000 will be diverted from the highway system. Most of the remainder will be diverted rapid transit trips.

- South Station Capacity. Construction of the Rail Link will eliminate South Station capacity problems that will become severe after the turn of the century. Old Colony service planned for 1996 and electric Metroliner service scheduled for 1998 will raise South Station track needs to sixteen—three above the thirteen that will be available when current track additions are completed. Further needs for up to eighteen total tracks have been identified for early during the Twenty-First Century. Building the Rail Link will provide adequate railroad station capacity in downtown Boston into the indefinite future because of the inherently greater efficiency of run-through Rail Link services as compared with those currently provided by the North and South Station stub-end terminals.

- Construction Costs. Costs of $1.85 billion are anticipated for construction of the Rail Link and for electrification and electric motive power for the rail lines from Providence to Haverhill and Lowell to Stoughton. Of this total, $1.3 billion will be for the Rail Link and stations. During the first quarter of the Twenty-First Century, another $1.78 billion will be required to complete electrification of the regional rail system, and provide associated electric motive power.

- Project Timing. Because of the time necessary for environmental analyses, project engineering, and resolution of institutional issues, it is not feasible to begin Rail Link construction in 1993 concurrent with that of the depressed Central Artery. Building Artery project slurry walls that extend down to the full depth necessary for both Artery and Rail Link construction, however, will make it possible for Rail Link construction to begin later than Artery construction.

CRITICAL NEXT STEPS

In order to move rapidly toward Phase I Rail Link construction consistent with the Artery construction schedule, the Task Force has identified a number of critical steps that need to be taken in the immediate future.

- Supplementary Excavation Support Wall Construction. Building the Rail Link in the Artery alignment requires that deeper supplementary excavation support walls be included in the construction packages to be advertised in mid-1993. These walls will allow later Rail Link construction while leaving the Artery construction schedule unaffected. The Task Force recommends separate funding for design and construction of the supplementary support walls, independent of Artery financing. In order to retain complete flexibility, it is recommended that the supplementary walls be included in the construction packages as items which can be deleted ("deletive items") at no cost to the Commonwealth in the event that separate funding is not made available for the Rail Link.

- Rail Link Funding. During the period 1993-1998, funding in the amount of $1.8 billion will be needed for design and construction of the Rail Link in the Central Artery Corridor, and for initial rail system electrification including stations, other fixed facilities, and rolling stock. Some immediate funding is necessary to continue Rail Link design, begin environmental analysis, and allow initial construction of deeper supplementary slurry walls.

- Environmental Analysis. Because the Rail Link and associated intermodal regional rail service network will be significant transportation investments, environmental analysis and an Environmental Impact Statement (EIS) will be required. It is the understanding of the Task Force that an EIS can be developed concurrently with preliminary engineering. It should be expected that at least eighteen months will elapse from the project start date until all environmental studies and preliminary engineering for the Rail Link can be completed.

- Preliminary Design/Engineering. It appears that design/engineering will take place in a number of separate packages involving different segments and elements of the project. In order to expedite preliminary design/engineering, as well as associated environmental analysis, the Task Force recommends creation of a Rail Link Project Office, to operate in close cooperation with the existing Central Artery/Tunnel Project Design Team, under the direction of the Executive Office of Transportation and Construction. It is anticipated that this Rail Link Project Office will have significant participation from Amtrak and the MBTA.

2 Service Opportunities and Benefits

THE RAIL LINK IN THE CONTEXT OF RAIL SERVICE AND RIDERSHIP GROWTH

Over the last 20 years, Amtrak has been instrumental in the revival of intercity rail passenger service in the United States. Amtrak is now thriving as it consistently improves its ridership, popularity, and fiscal performance, and Amtrak's intercity rail service plays a major role in regional transportation for New England and the Northeast. Improvements such as electrification of the Northeast Corridor and the anticipated purchase of a new generation of high speed equipment are underway. In 1994, Amtrak will restore intercity rail service from North Station in Boston to New Hampshire, and Portland, Maine. Every state in New England will then enjoy intercity rail passenger service for the first time since 1965, and service will be available along the entire eastern seaboard from Maine to Florida. (See Figure 2.)

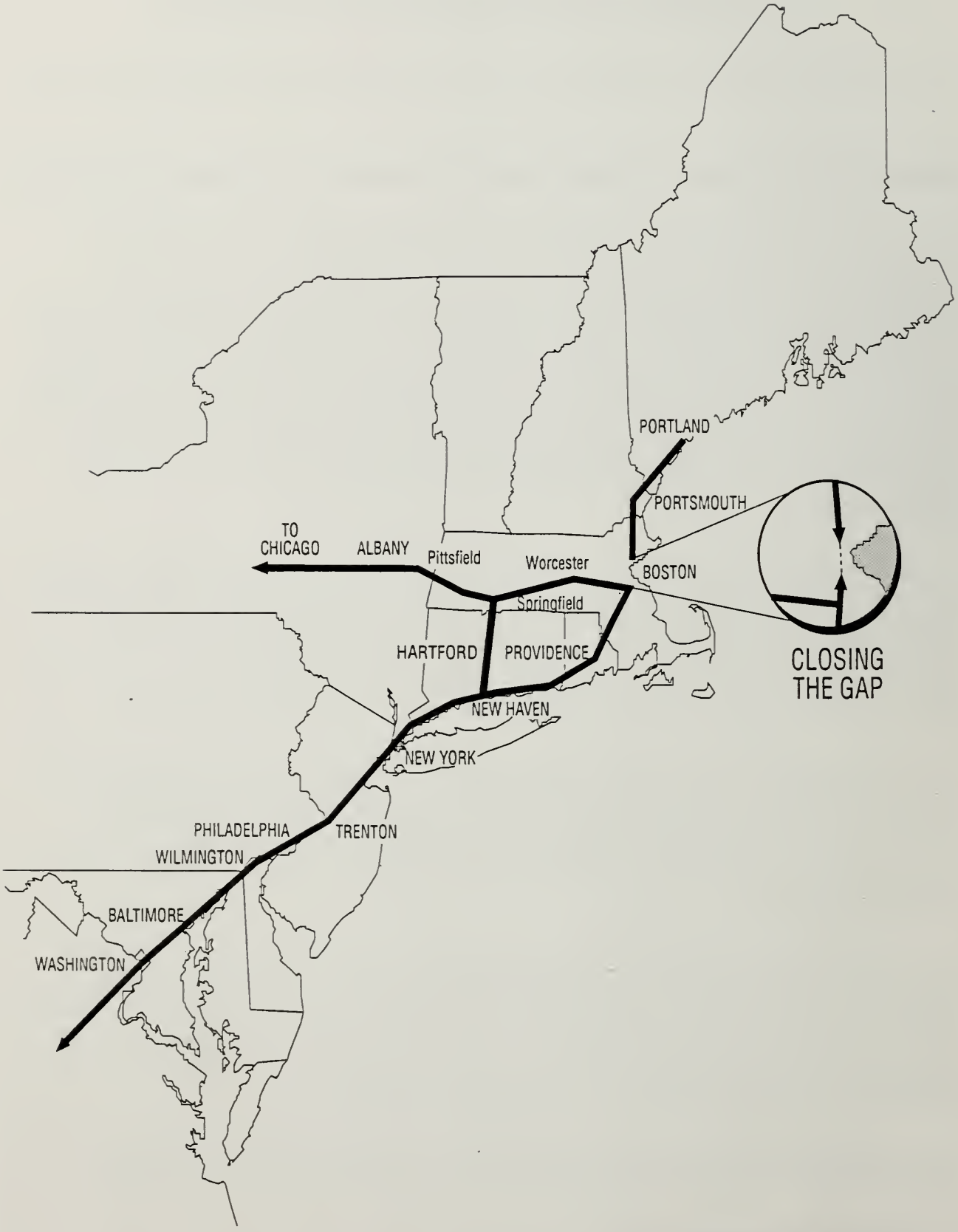
Paralleling the national intercity rail revival has been a local renaissance of commuter rail passenger service in Eastern Massachusetts. Starting from a nadir in the mid 1970's, new equipment has been purchased, service has been increased, and ridership has more than doubled. Construction has now started to allow re-establishment of Old Colony commuter railroad service south of Boston for the first time since 1959. Other commuter rail extensions are actively being planned.

This national and local renaissance of intercity and commuter rail passenger services creates a problem and an opportunity. The problem is that Boston is running out of downtown railroad terminal capacity. The opportunity is that construction of the Rail Link at this time will open a wide range of new transportation options while simultaneously relieving downtown railroad station capacity constraints.

Currently, passenger railroad service into and out of Boston—both intercity and local—is provided by two physically isolated systems. One stretches in northerly directions from North Station at the northern edge of downtown Boston. The other serves areas to the south and west of Boston from South Station, located at downtown Boston's southern fringe. The two stations are separated from one-another by a distance of just over one mile (see Figure 3).

Together, these two systems have eleven different rail routes in Eastern Massachusetts serving 53 communities with a total of 101 stations. Five of the

Figure 2
Northeast Corridor Rail Services



Source: Central Artery Rail Link Task Force

Figure 3

Locations of Existing North and South Stations in Downtown Boston

Source: Central Artery Rail Link Task Force

routes, with 52 outlying stations terminate at North Station; six of the routes, with 46 outlying stations, terminate at South Station. Intercity service to New York, Washington, and Chicago, now is confined to the southern system, but the northern system will be used when Amtrak service is extended to Portland, Maine.

Completion of the Rail Link will unite these two systems into one system providing convenient and efficient through service for Amtrak intercity trains as well as for the rapidly growing regional rail services in Eastern Massachusetts. With the Rail Link, Amtrak will be able to run through service connecting cities north and south of Boston with no transfers. Concurrently, the MBTA will be able to develop and operate seven through routed regional rail services linking communities on the northside of metropolitan Boston with their southside counterparts. Figure 4 shows the Rail Link in downtown Boston.

The remainder of this chapter considers both the need for and the expected benefits from the North/South Station Rail Link. Need is considered in the context of past and future anticipated growth of intercity and local passenger services. Benefits are discussed in eight areas as follows:

- **Improved, through-routed intercity rail service**
- **Metropolitan-areawide rail system interconnectivity**
- **Increased capacity for downtown railroad station facilities**
- **Improved core area trip distribution**
- **Reduced core area rapid transit system congestion**
- **Improved air/rail connections**
- **Highway/rail integration potential**
- **Improved regional air quality**

Transportation improvements will contribute to increased mobility and offer new transportation options not only for persons within metropolitan Boston, but for the entire Northeast Corridor and beyond. Air quality benefits will accrue to all.

Growth of Amtrak Service and Passenger Volumes

Amtrak currently provides a total of twenty-six combined train arrivals and departures to points south and west from South Station each day (thirteen in, thirteen out). Of the thirteen daily runs in each direction, ten provide Northeast Corridor service to New York and Washington via Providence, two provide similar service via Worcester, Springfield, and Hartford, and one goes to Chicago via

Figure 4

Central Artery Rail Link

Source: Central Artery Rail Link Task Force

Worcester, Springfield, and Albany. (See Table 1.) No Amtrak service is currently offered to points north of Boston.

Table 1
Amtrak Service Levels and Ridership:[1] 1992 and 2010

Station	1992		2010		1992-2010
	Train Departures/ Arrivals	Average Daily Riders	Train Departures Arrivals	Average Daily Riders	Ridership Growth (Percent)
South Station	26	2,000	58	4,100	105%
Back Bay Station	26	400	58	800	100%
Route 128 Station	20	400	52	900	125%
North Station	0	0	12	1,400	-
Total	26	2,800	70	7,200	160%

[1] Boardings and alightings combined.

Altogether, the current Amtrak services are patronized by about 2,800 Boston area passengers a day (boardings and alightings combined) of which about 70% entrain or detrain at South Station. On peak days of the year, ridership levels can more than triple.

When the Northeast Corridor improvement project is complete, faster Metroliner service will be in operation between Boston and New York, and overall service levels will be increased. By the year 2010, Amtrak expects to offer approximately fifty-eight Boston trains to/from points south and west, more than doubling todays totals. With improved service, ridership is also expected to more than double by 2010, and Amtrak will become the leading carrier in the Boston-New York market.

Intercity rail passenger service north from Boston was abandoned during the mid-1960's, and has yet to be re-established. Amtrak has plans, however, to begin a new northerly service from Boston to Portland in 1994. At the start, this service is anticipated to have three trains daily in each direction via Exeter and Dover, New Hampshire, and Wells and Saco, Maine. By the year 2010, Amtrak expects to have six trains daily in each direction between Boston and Portland. Initial ridership estimates for the Portland service have projected up to 1,400 boardings on an

average day (700 in each direction). New projections are currently being prepared for the Federal Transit Administration.

Adding projected ridership levels together for northerly and southerly/ westerly routes from Boston, Amtrak currently anticipates serving 7,200 Boston area passengers daily by the year 2010. With improved Rail Link services, the future Amtrak ridership projections are expected to be higher.

Growth of Regional Commuter Rail Services and Passenger Volumes

From a mid-1970's low point of about 30,000 trips daily on the northerly and southerly commuter rail systems, Boston's commuter railroad ridership has grown to a current total of about 70,000 trips daily (35,000 round trips), an increase of 150% (see Figure 5). Of the current riders, about 40% use the northside system, 60% use the system to the south.

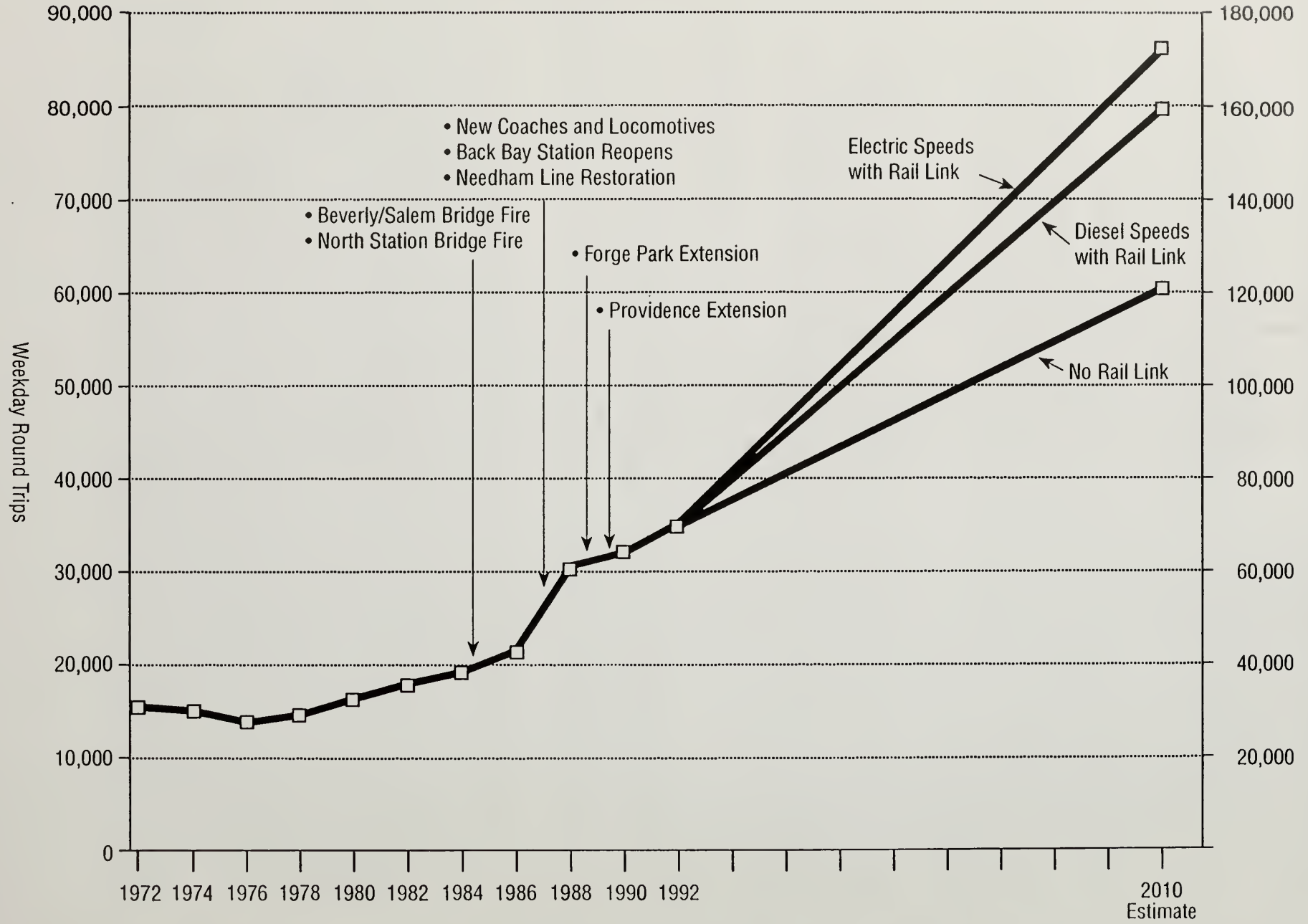
Year 2010 commuter rail ridership estimates have been prepared using the Eastern Massachusetts regional travel demand forecasting models maintained by CTPS. For the baseline Year 2010 scenario, not including the Rail Link, models currently project a 70% increase in commuter rail ridership above present levels. (Also shown in Figure 5.) This very substantial increase to a total of 120,000 rides a day (60,000 round trips) results from the following:

- Major commuter rail service area increases provided by Old Colony service.
- Additional service area increases provided by planned commuter rail service extensions to Worcester and Newburyport.
- Land use projections anticipating a growth of 30% in employment to the year 2010 for the area in and near downtown Boston.
- Regional housing growth in "bedroom suburbs" better served by commuter rail to downtown Boston than by competing modes.

Future ridership projections assuming the Rail Link connection have been prepared for two scenarios. One assumes commuter rail running speeds equivalent to those provided today with the existing diesel powered train fleet. The second assumes increased running speeds achievable with a faster all-electric service. This second scenario was evaluated because of safety-related restrictions on operating diesel services in tunnels such as the Rail Link, and the resultant expectation that the MBTA commuter railroad system ultimately will become all-electric in association with the regional run-through operations of the Rail Link tunnel.

Ridership projections for the year 2010, that assume Rail Link operations with diesel operating speeds, show a rise of 39,000 daily rides to 160,000, a ridership increase of 32% above the 2010 no-Rail Link result. With all-electric service,

Figure 5
Average Weekday Commuter Railroad Ridership: 1972 – 1992 and 2010



Source: Central Transportation Planning Staff

ridership goes up an additional 17,000 daily rides, or 11%, to a total of 177,000 rides daily (88,000 round trips). With Rail Link operations and all-electric service, total commuter rail ridership is projected to be 57,000 rides daily higher than without the Rail Link. Of these 57,000 rides, approximately 23,000 were previously highway commuter trips, most of the remaining 34,000 were trips made by travellers who had been using rapid transit. The total 177,000 daily rides represents a regional rail ridership increase of 153% over today's levels. (See Figure 5.)

BENEFITS OF RAIL LINK OPERATIONS

The Central Artery Rail Link connection between North and South Stations will serve a variety of transportation objectives for the Amtrak system, for New England, and for the metropolitan Boston region. Included among its benefits will be:

- Improved, through-routed intercity rail service between points north of Boston and areas to the south and west.
- Improved regional rail interconnectivity with northside and southside services joined and through-routed.
- Increased capacity for accommodating additional intercity and commuter trains in downtown Boston.
- Improved core area trip distribution for north and southside rail passengers with through intercity and commuter service, and direct connections to all MBTA rapid transit lines.
- Congestion relief for key elements of the MBTA rapid transit system in the Boston core area.
- Improved air/rail connections to Logan Airport with direct regional and intercity service from all locations to the South Station Transportation Center.
- Strengthened highway/rail integration with the regional network of circumferential radial routes including intermodal connections to the inner and outer metropolitan Boston ring roads (I-95 and I-495).
- Improved air quality for the metropolitan Boston region.

The remainder of this chapter will consider how the Rail Link will confer these benefits in the context of an alignment within the right-of-way of the depressed Central Artery.

Intercity Rail Service: Extending the Northeast Corridor—When Amtrak restores intercity rail service to New Hampshire and Maine, the Amtrak system will stretch along the East Coast from Maine to Florida, and across the nation from East to West. The most significant break in the system will be between North and South Stations in Boston. The Rail Link will close the gap and provide numerous benefits to rail travelers and Amtrak:

- It will be possible to ride directly from Portland, Maine and New Hampshire to South Station and beyond. Overnight service will leave Maine after dinner and arrive in Washington, DC, for breakfast with no change of equipment. Travel times between Portland and New York will be very competitive with those of other surface transportation modes.

- Portland, Maine trains terminating in Boston will have excellent connections at South Station to trains serving southside regional rail services and intercity rail services to points south and west.

- Rail Link travelers in northeastern Massachusetts will enjoy convenient rail access to intercity service by taking MBTA regional rail service from home areas to downtown stations or other major stations, and making convenient cross-platform transfers to Amtrak.

- Amtrak will have the opportunity to originate some of its New York-bound service in the northern portion of metropolitan Boston (e.g., Lawrence/ Woburn) allowing northside passengers direct access to intercity rail service with convenient long-term parking.

- Amtrak will enjoy operating efficiencies by being able to service Portland trains at its main service facility in South Boston. Without the Rail Link, this facility would be too remote for daily access to and from North Station.

In essence, the Rail Link will extend the Northeast Corridor 115 miles northeast to Portland, Maine. Although initial Corridor service between Portland and Boston will be slower than service south of Boston, overall travel speeds between Portland and New York will still compare favorably with those of the private automobile. Ultimate electrification to Portland would significantly increase average speeds by eliminating a 20-minute engine change and providing superior acceleration from station stops.

Amtrak has not determined how it would ultimately operate its New England service with the Rail Link in place, but it is known that a substantial number of Amtrak services would be offered north of South Station via the Rail Link, and that the integration of New Hampshire and Maine into the overall network would be greatly strengthened. Although specific ridership projections for integrated services have yet to be completed, it should be expected that demand for

Amtrak service north of Boston will be greatly stimulated by creation of the extended Northeast Corridor.

Creating Regional Rail Interconnectivity—When the Rail Link opens, it will be possible to transform the MBTA commuter rail network into a true regional rail service following service models operated in Europe and Japan and piloted on this continent by Philadelphia. Under the regional rail concept, the local rail network's role in the coordinated transportation system is upgraded from a predominantly commuter oriented service, with limited off-peak service, to an all-day all-purpose passenger transportation resource designed for a wider range of travel purposes and destinations. Philadelphia used this service concept when it opened its Center City Rail Connector in 1984. With the Central City Tunnel of the Philadelphia regional rail system, there are three principal distinguishing service characteristics:

- Most local rail trips run through the tunnel. Inbound trips from one side of the city become outbound trips on the other side. Services on one side of the city are paired with services on the other to facilitate regular "crosstown" service.

- Frequent service is the norm. Constant off peak service strengthens peak service by providing riders with more flexibility. Frequent off-peak service makes the railroad much more attractive for non-commuter trips.

- The run-through design and frequent service facilitate transfers from one line to another. Waiting time for a transfer from one rail line to another averages fifteen minutes or less during peak hours, and thirty minutes during off-peak. Service is competitive for many trips with travel by automobile.

A key consideration in designing regional rail service is designating the pairs of lines that will be united to form single service lines once the Rail Link is operational. In allocating rail pairs, several considerations must be evaluated:

- Ridership
- Running Times
- Geography
- Train Lengths
- Route Length
- Travel Patterns

Because it is envisioned that only electrified service will be used in the Rail Link tunnel, the possible sequence of providing electric catenary on the existing diesel lines is also considered in making the rail line pairs.[1]

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[1] For more detail on the sequencing of rail pairs, see Chapter 4.

For planning purposes, the following through rail lines have been identified in order to model and evaluate the prospective performance of the electrified regional rail operation. Further study or operating experience may show the superiority of other potential rail pairings. The proposed regional rail network is shown in Figure 6.

A Line - Intercity Amtrak service between Portland and New York will follow a route through Haverhill, Boston, and Providence. An MBTA regional service would be developed to follow this high performance route on an hourly service frequency. This route would have two subsidiary branches: a northern branch serving Billerica and Lowell, and a southern branch serving Stoughton.

B Line - The operation of the branch services over the same Wilmington to Canton trunk used by the Haverhill/Providence service will double the effective frequency of trains along the trunk attracting additional ridership. The regional rail system's two largest intermodal (railroad/highway/bus) facilities would be located at the points where the A Line crosses the I-95: Mishawum/Industriplex on the north and the present Route 128 station on the south.

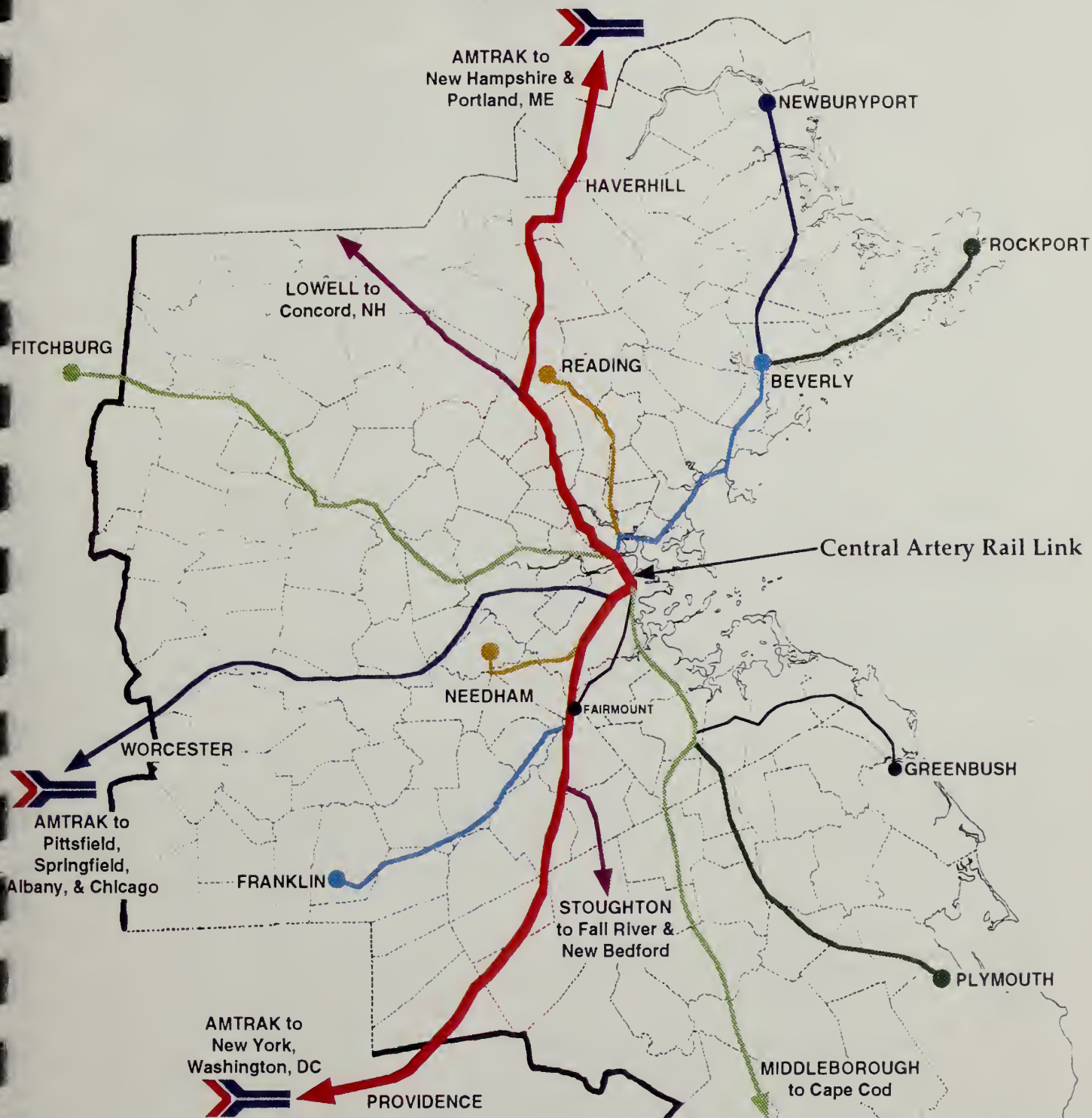
C Line - The C Line is envisioned as a route linking coastal communities to the north and south of Boston. The main axis of the C Line would run from Plymouth to Boston and then proceed north to Gloucester and Rockport on Cape Ann. These two existing lines would be complimentary in their length, running time, and market penetration relative to Boston highway access.

D Line - The MBTA Franklin Line would be operated in conjunction with the C Line service. It shares approximately ten miles of right-of-way with the A and B lines between South Station and the southern Boston city limits. Like the Rockport line, the Franklin service enjoys a travel time advantage over the highway for trips to Boston. Through-routing the Franklin service to Beverly will relieve the potential for crowding on trains serving the northern end of the C Line, and will improve service frequencies between Beverly and Boston.

E Line - Intercity rail service linking Boston with Springfield, Hartford, Albany, and Chicago will follow a route through Framingham and Worcester. For the purposes of the regional Rail Link plan, this line would be through routed with the Newburyport service to the north. The E Line would operate in the same corridor as the C Line between Chelsea and Beverly.

F Line - Two of the longest commuter rail lines are the Fitchburg and Middleboro services. In both cases, these lines are located in corridors with circuitous and congested highway access to Boston. Consequently, both enjoy

Figure 6
Regional Rail Network



Source: Massachusetts Bay Transportation Authority

a high rail mode share for radial trips. Together these two services would form the Northwest-Southeast regional rail line.

G Line - Two of the shortest legs of the existing commuter rail service are the Reading and Needham services. Both services are characterized by close station spacing and a relatively dense network of supporting and alternative transit services. Linking these two short lines together would yield service with similar operating and ridership characteristics. This would suggest comparable equipment and crew requirements.

Fairmount and Greenbush Lines - Due to the fact that there are more routes to the south than to the north of Boston, and also because of practical limitations on the capacity of the Rail Link, it is expected that the Fairmount and Greenbush services would continue to operate into and out of the present South Station using diesel motive power. Connections for points north would be available by transferring to northbound trains using the Rail Link at South Station.

Summary statistics regarding route lengths and potential travel time savings for the through-routed electrified regional rail system are shown in Table 2.

Table 2
Travel Distances and Time Savings for Through-Routed Regional Rail System

Route Letter	Route Description	Route Length (Miles)	Travel Time Reduction	
			South Leg	North Leg
A	Providence-Haverhill	78	25%	22%
B	Stoughton-Lowell	46	13%	13%
C	Plymouth-Rockport	71	-	18%
D	Franklin-Beverly	50	10%	18%
E	Worcester-Newburyport	84	12%*	22%*
F	Middleboro-Fitchburg	88	-	12%
G	Needham-Reading	28	12%	7%
	Average	64	14%	16%

*From existing termini.

As can be seen in the table, the end-to-end length of the average through-route will be about 64 miles. Travel time reductions due to electrification will average about 15%.

A complete schematic of the regional rail system is shown in Figure 7. As indicated by the figure, a total of 143 separate stations will be served by the nine regional rail routes.

Increased Capacity for Downtown Railroad Station Facilities—South Station is operating at near capacity now, and will reach its practical capacity over the next several years. Unless accommodations are made, it will be unable to handle the numbers of intercity trains anticipated by Amtrak, as well as the increased numbers of regional trains required by a growing commuter service. North Station currently has adequate capacity, but may ultimately suffer the same fate.

The following is a specific discussion relating rail service growth to North and South Station capacity. In the discussion, current and projected levels of train service are related to station track requirements.

From a capacity planning perspective, at a stub-end terminal such as North or South Station, it takes up to thirty minutes for a commuter train to occupy, unload, turn, and clear a station track. For a variety of reasons, an Amtrak train can take up to an hour from the time it enters to the time it clears the station area. Relating these capacity-determining parameters to North and South Stations is fairly straightforward.

North Station currently has ten tracks that accommodate thirteen commuter trains during the peak hour. In the future, if Amtrak berths two peak hour trains, Amtrak will occupy the two additional tracks that are planned for North Station. If the number of commuter trains is increased with higher service frequencies to yield five additional peak hour trains, there will still be some available track capacity at North Station.

South Station now has fourteen commuter rail departures during the peak hour. Amtrak has two departures and one arrival during this hour. Based on the above parameters, this yields a total peak hour requirement for ten of the existing eleven tracks, which means that peak demand is approaching capacity. Within the next several years, two tracks will be added to South Station, but Old Colony commuter service will add six more peak hour trains. This will raise peak hour demand to thirteen tracks. South Station will be at capacity (see Figure 8).

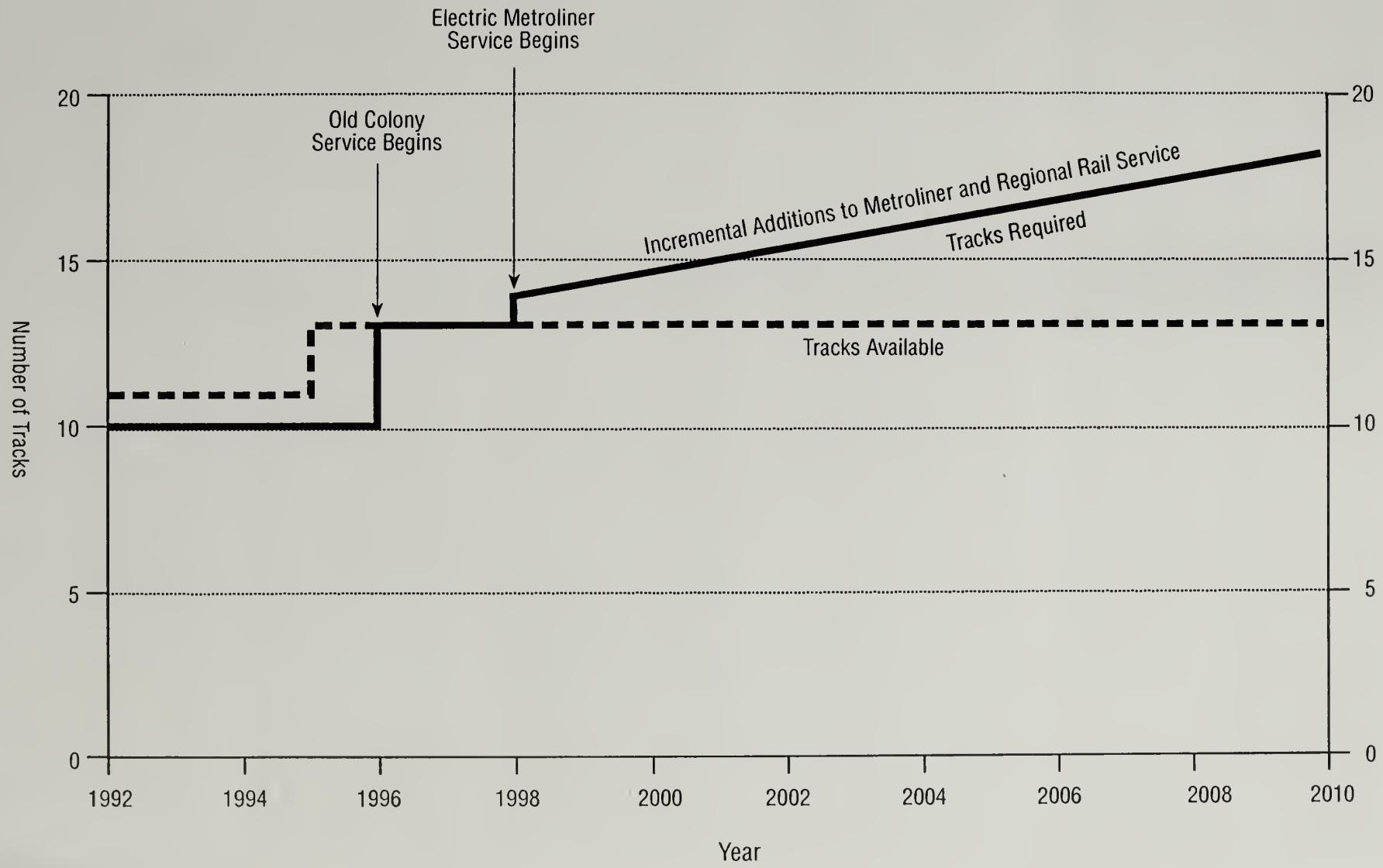
By 1999, high speed service improvements to the Northeast Corridor are expected to be complete, and Metroliner-type service will begin, increasing the numbers of trains that need to occupy South Station during peak periods. Although Amtrak service frequencies probably will increase incrementally, it is not unreasonable to assume a forseeable demand for six peak hour Amtrak train

Figure 7

Regional Rail Network Schematic

Source: Massachusetts Bay Transportation Authority

Figure 8
South Station Tracks Available Versus Tracks Required



Source: Central Transportation Planning Staff

movements. Increased Amtrak service will bring total South Station track requirements to at least fifteen and possibly sixteen tracks during the peak hour. When this happens, South Station will experience track capacity problems.

With projected future increases in commuter demand, the situation can become worse. Express trains, skip stop trains, short-turn trains, and other service strategies will be required to carry all the passengers that wish to travel to Boston. Each express train or other adaptive capacity-increasing strategy will become an additional train requiring station time in the city. Eventually, train movements on many lines will operate at fifteen-minute average peak hour frequencies. With this development, commuter operations would rise to as high as twenty-eight peak hour commuter trains.

Combining Amtrak and commuter needs, the future number of stub-end tracks needed at South Station could be as high as twenty using the parameters of one hour per Amtrak train, and one-half hour per commuter train. With operating efficiencies, a more realistic requirement would be for sixteen to eighteen tracks. Either way, future track needs are projected to be considerably higher than the thirteen tracks currently planned for South Station. Unless something is done, South Station will experience capacity problems by the turn of the century and these problems can only become more severe as time goes on.

With future requirements exceeding planned South Station stub-end terminal capacity, other means must be found to serve all of the anticipated train movements. The Rail Link presents a compelling opportunity to achieve this end by substituting run-through for stub-end services. Since run-through tracks can process as many as six times as many trains per hour as stub-end tracks, the four-track Rail Link can potentially offer the same station services as a twenty-four track stub-end terminal. With the link, most train operations can become run-through services, leaving enough available stub-end capacity for any likely needs as far into the future as can be reasonably projected.

Downtown Core Trip Distribution Improvement—Most transportation services involve travel in three phases: trip collection, linehaul, and trip distribution. For most inbound commuter rail trips, the typical trip collection phase is provided by a private automobile belonging to the traveler. The railroad provides the linehaul. Trip distribution, the last phase, is usually provided by rapid transit or walking. It is this last phase where commuter rail sometimes is not viable because the trip from the rail station to the non-home destination is too inconvenient.

With the Rail Link, trip distribution characteristics of the regional railroad system will be very much improved in three respects:

- The regional rail service will be able to serve as its own trip distribution mode by providing service to a larger array of downtown destinations. Most trains

will call at Back Bay, South Station, Central Station, and North Station. Much of downtown Boston is within easy walking distance of these four stations.

- Many northside patrons will find it easier to ride through to Central, South, or Back Bay stations rather than walk or ride the Green or Orange Line further south. Many southside patrons will find the converse to be true.

- The four downtown stations will provide a full spectrum of direct connections to the four MBTA rail transit lines. Easy direct connections to all four lines will improve the utility of rail transit as part of the trip distribution leg of the traveler's journey. Almost all regional rail trips will have a direct connection to all four rail transit lines.

The four downtown stations will provide excellent pedestrian access and rail transit connections in a variety of ways:

- **North Station -** The North Station stop of the Rail Link will be below Causeway Street and convenient to the Green and Orange Lines. Boston Garden and the new Thomas P. O'Neill Federal Office Building are found on the street above, and Massachusetts General Hospital, Boston's largest employer, is located a few blocks away.

- **Central Station -** The Central Station at State Street will boast a direct connection to the Blue Line and provide for easy walk access to Quincy Market, Government Center, International Place, Post Office Square, the Waterfront and the north end of Downtown Crossing.

- **South Station -** the South Station stop on the Rail Link will have a direct connection to the Red Line, the South Boston Transitway, and the major bus terminal located in the South Station Transportation Center (SSTC). It will provide for easy walk access to the Financial District, the southern end of Downtown Crossing, Chinatown, Rowe's Wharf, and Fort Point Channel including "Museum Wharf."

- **Back Bay Station-** The Back Bay stop enjoys a direct connection to the Orange Line and affords easy walk access to Back Bay, South Bay and the South End.

Table 3 shows downtown commuter rail boardings for the year 2010 without and with the Rail Link. As can be seen from the Table, North Station boardings rise modestly from 14,500 to 16,400 with construction of the Rail Link and system electrification. Central Station boardings are about the same as those of North Station: around 15,000 passengers. South Station boardings grow dramatically with the Rail Link and regional rail system electrification: from 27,000 boardings to 41,000 boardings. Back Bay boardings grow modestly: from 9,000 to 12,000.

Table 3
Projected Daily Commuter Rail Boardings: Year 2010

Station	Baseline No Rail Link	Rail Link System	
		Diesel Traction	Electric Traction
North Station	14,500	14,500	16,400
Central Street	-	13,400	15,200
South Station	27,200	37,000	40,900
Back Bay Station	9,300	11,000	12,200
Total	51,000	75,900	84,700

The projected ridership response to the trip distribution benefits of the Rail Link are dramatic in the shifts of trips to stations closer to most passengers' ultimate destinations. There are also shifts in the use of rapid transit as commuter rail offers more connections and can serve as its own trip distributor for many more trips. There will be significant synergy between the Rail Link and the Transitway. With the Rail Link the number of projected transfers between commuter rail and the Transitway is expected to nearly double from 11,900 without the Rail Link to as much as 25,200 with the Rail Link and system electrification.[2]

Rapid Transit System Congestion Relief—A key finding of the travel demand analysis is that construction of the Rail Link combined with faster electrified regional rail service, will shift approximately 56,000 daily trips or about 7% of total ridership from the MBTA rapid transit system. About 34,000 of these trips will be complete commutes where travelers will simply switch from rapid transit to the improved regional rail system. In the remaining 22,000 trips, commuters who today use commuter rail and transfer to rapid transit will instead continue on the Rail Link to a station near their final destination, eliminating the need to transfer for the downtown portion of their trip. This latter type of change will be most noticeable for the Orange Line, which parallels the Rail Link and currently serves as an important distributor from both North Station and Back Bay Station.

Although diversions from rapid transit to commuter rail will constitute a relatively small proportion of rapid transit ridership, they will nonetheless be significant and may cause noticeable rapid transit congestion relief. For riders who

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[2] Projected transfers between the Rail Link and the Transitway are among the highest along the Rail Link corridor. Other transfer volumes with the Rail Link and system electrification include: Red Line - 22,800, Blue Line - 7,500, Green Line - 8,200, Orange Line North - 10,200, Orange Line Back Bay - 5,900.

make the switch from rapid transit to commuter rail, the change will be to a more comfortable mode with generally seated service. For those that no longer need the downtown transfer, the change will eliminate transfer uncertainty and will provide single ride service that is considered by most persons as inherently far superior to service requiring transfers.

Air/Rail Connections—A key design consideration and traveler benefit of the Rail Link is the quality of the air/rail connection provided between the intercity/regional railroad and Boston's Logan Airport. There are three important air/rail benefits.

- A principal motive for intercity rail improvements is to relieve Logan Airport congestion by shifting some short and medium distance trips (New York, Philadelphia and Washington) from the airlines to Amtrak.

- A convenient and reliable connection to Northeast Corridor rail service from Logan Airport can be a more attractive and efficient destination for international and continental flights which can fill the slots opened by reduced shuttle operations.

- The regional rail service can ameliorate ground access congestion at Logan Airport by providing convenient and frequent rail trips between most suburbs and the airport. Some airline baggage and ticketing functions could be provided at certain outlying locations.

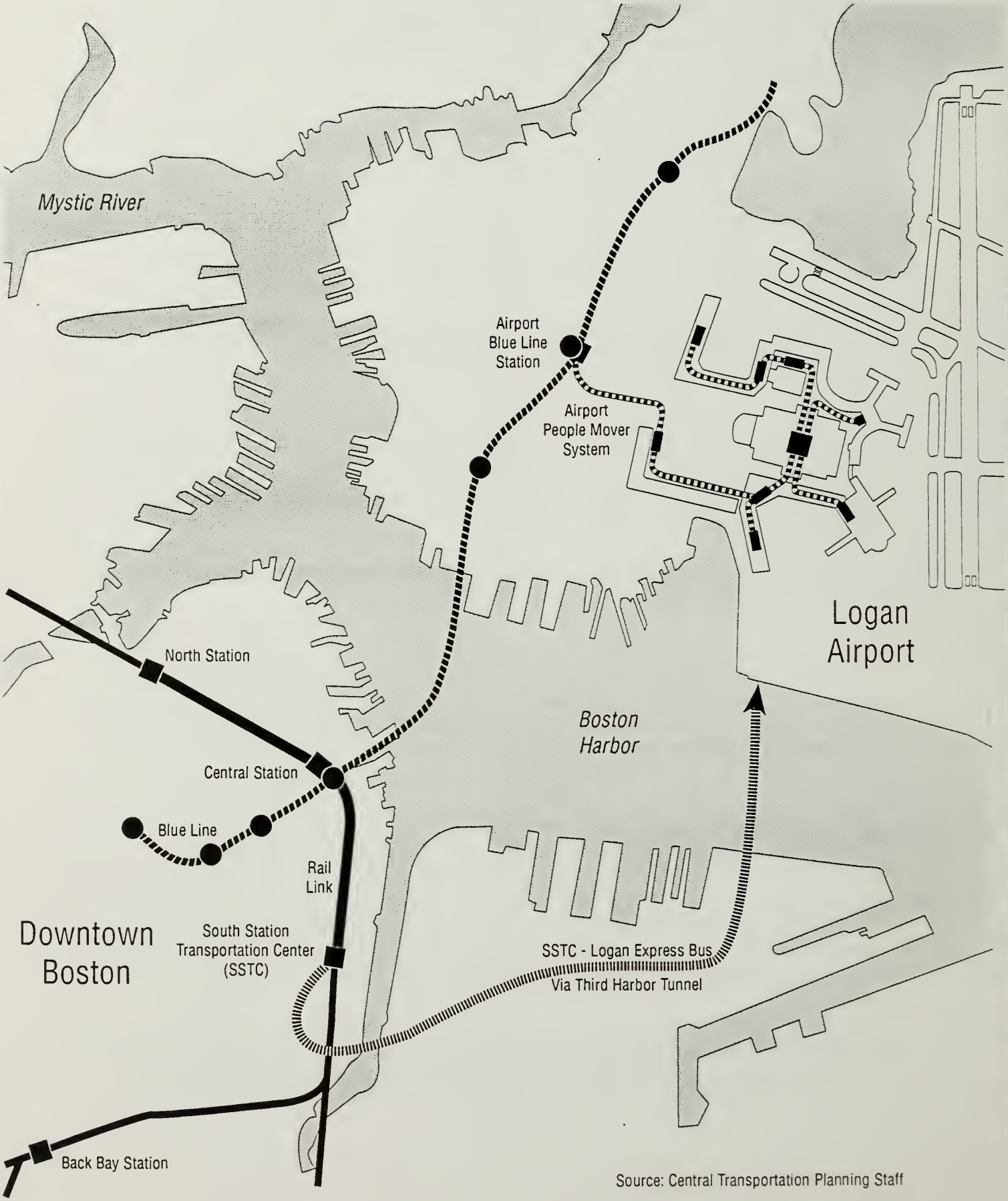
Four projects currently in the planning or construction phases would advance these intermodal objectives in conjunction with Rail Link service.

- **Northeast Corridor Improvements** - Boston to New York rail service with running times below three hours will shift travel demand from air to rail for short distance travel in the northeast market. The Rail Link will provide direct rail access to this service for a much larger proportion of New England by allowing through routed Amtrak service from the north and by providing for cross platform transfers for the entire northside regional system.

- **South Station Transportation Center (SSTC)** - The new SSTC will be an integral component of the regional rail network. It has been designed for excellent connections to the airport by providing a dedicated priority ramp into the new Boston Harbor tunnel for buses to the Airport. (See Figure 9.) The bus service will provide direct access to each terminal at the airport. Specially designed airline coaches are expected to be used for the bus service facilitating baggage handling and passenger support requirements.

  Combining the Rail Link with the SSTC, all Amtrak and regional rail passengers will have a direct connection to Logan Airport via the SSTC-Logan express bus service. Similarly, all air travelers will have direct Logan-SSTC service to all Amtrak and regional rail routes.

Figure 9
Logan Airport Connections



Source: Central Transportation Planning Staff

- **Blue Line Connection -** The MBTA Blue Line will continue to serve as a general purpose gateway to Logan Airport. Today the Blue Line serves approximately 8% of air passenger travel to Logan, despite a lack of direct connections to either the regional rail network or the MBTA Red Line. With the completion of the Rail Link, regional rail trains will stop at Central Station providing a direct connection to the Blue Line and greatly improving regional access to the airport. At the airport end, the Logan Airport Modernization Program (LAMP) envisions a people mover network linking the Blue Line with each of the air terminals. This linkage is also shown in Figure 9. With improvements at the MBTA Blue Line station, the Blue Line people mover link will provide friction-free circulation between rapid transit and airline services.

- **"Satellite" Air Terminals-** It is anticipated that airline baggage and ticketing functions will be constructed at satellite air terminals. At a minimum such facilities would be expected at the Route 128 station south of Boston and Mishawum station north of Boston both located on the A and B lines. Such facilities could be extended to other stations where the railroad intersects major highways. These developments would require the provision of long term parking at suburban locations.

Highway/Rail Integration—The regional transportation network can be strengthened by improving the connections between rail service and the suburban highway system. Many railroad station locations no longer serve the original historic destinations for which they were built. Few relate well to major highway destinations. With Rail Link-inspired operation of a regional rail network, the potential for synergism between railroad lines, highways, and surrounding landforms will be much improved.

For many reasons highway/railroad development projects have failed to spur other development projects in adjoining areas. Some factors are:

- **Proximity without access -** Frequently the rail station is close to the highway but hard to get to. Mishawum and Littleton/I-495 are examples of stations which are visible, but not easily accessible, from the highway.

- **Railroad scheduling patterns -** Rail service is usually oriented for the morning inbound commuter, with little counterflow or off-peak service. This makes it difficult for the railroad to serve suburban work and shopping destinations.

- **Local land use patterns -** Rail stations often are located where there is an absence of activity rather than a concentration since stations and parking require large amounts of land. Moreover, locations "down by the tracks" have not been prime locations for high volume population-serving activities.

This has not helped the commuter rail network become as well integrated to the fabric of suburban life as it could be.

- **Parking patterns -** Parking at suburban rail locations is in short supply today. For a station area to develop as a destination in its own right, substantial parking must be provided since a major portion of the clientele will access the location by auto, regardless of how good rail service is. This need for parking sometimes crowds out other complimentary land uses. Once again, creative planning, scheduling and bus service coordination are required for the rail location to achieve its potential as a multi-modal multi-use activity center.

Even though the full potential of suburban transportation centers has yet to be realized in the MBTA rail service area, several high volume rail/highway connections play an important role in regional transportation today. Two of the more prominent locations are on the north-south line: Route 128 in Dedham, and Mishawum in Woburn. These are shown in Figure 10. They will continue to be major stations with both regional and intercity service, as well as locations for specialized "Logan Link" services. The Route 128 and Mishawum stations should be planned and developed in response to the challenges listed above. Mishawum has a mall and joint development opportunities on nearby vacant land. Private/public cooperation in the Route 128 station area could also be promising. Coordination of local bus service into these terminals will also reinforce their potential as multi-modal multi-activity centers.

Looking to other locations in the regional transportation network it is possible to spot other promising locations for intermodal and related activity growth:

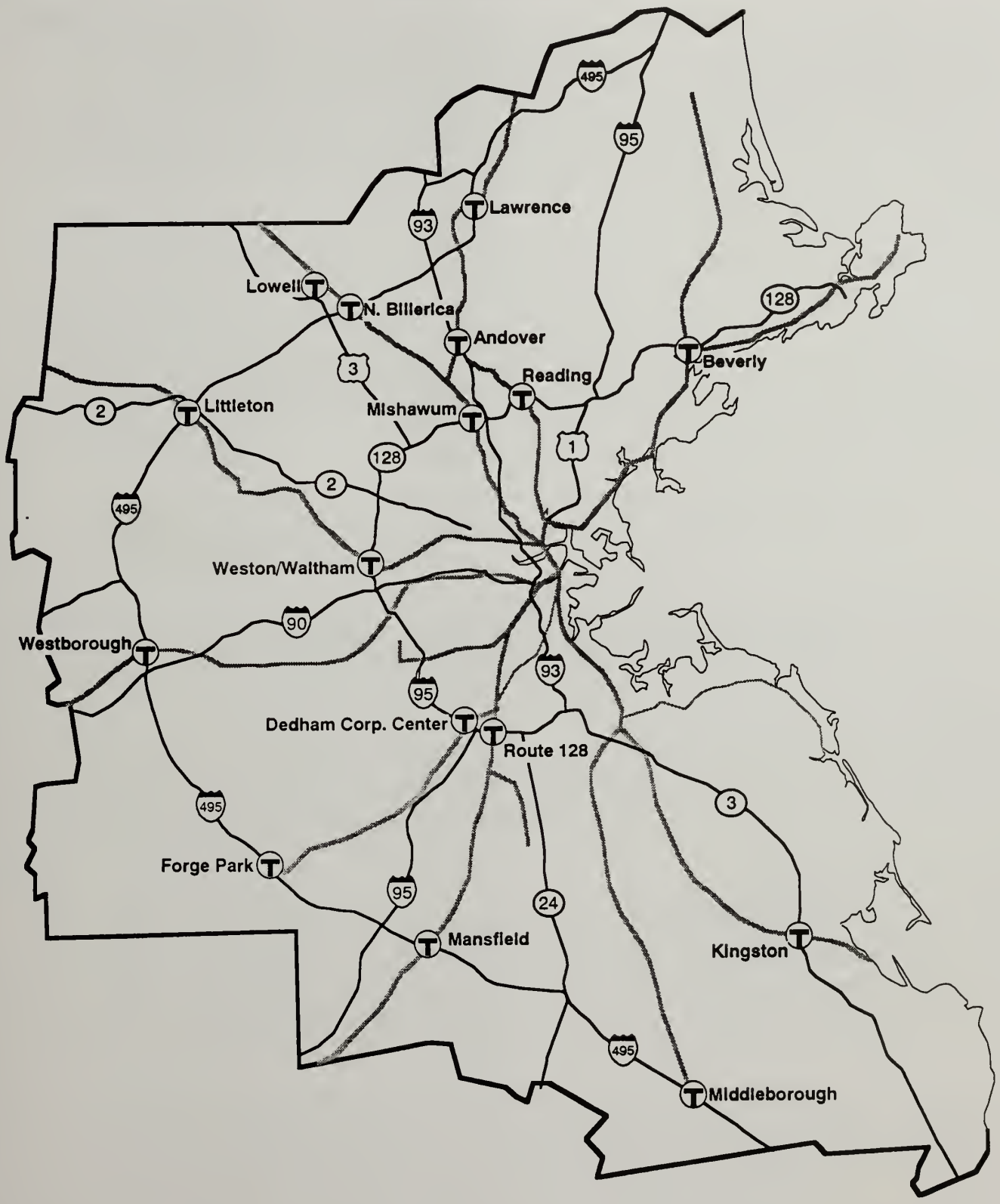
- **Along I-95:** Route 128 Dedham; Mishawum; Weston/Waltham; Dedham Corporate Center, Reading, Beverly
- **Along I-93:** Andover
- **Along I-495:** Lawrence; Lowell; North Billerica; Littleton; Westborough; Forge Park/Franklin; Mansfield; Middleborough

All of these additional locations are also shown in Figure 10. They will need to be investigated as plans for a regional rail system move toward reality.

If highway-rail integration is to fully meet its potential, major initiatives will be necessary to plan, design, and construct intermodal facilities with supporting nodal land uses at rail-highway interfaces. These intermodal facilities will need to carefully combine highways, stations, parking, and land developments to provide maximum synergy and functionality. In some cases, new stations may need to be constructed as parts of rail-highway activity centers.

For the new intermodal stations, non-traditional funding sources may be used to support the construction of amenities that are not typically available at

Figure 10
Major Highway/Rail Stations



Source: Massachusetts Bay Transportation Authority &
Massachusetts Highway Department

existing MBTA suburban stations. These amenities could include restrooms, enclosed waiting areas, food concessions, and other supporting retail services. The inclusion of these auxiliary services will make the intermodal centers more convenient and pleasant to use, while also reducing the number of non-work trips needed to be made by commuters. The activity center support services would also make the intermodal transportation centers more attractive to students, shoppers, tourists, and reverse commuters.

Air Quality Improvements

With fully electrified operation of the regional rail network through the Rail Link a significant improvement in air quality in and around Boston is anticipated. This improvement is due to both the elimination of diesel locomotives as a source of pollution and the diversion of travellers from the highway to transit modes. Estimates of the impacts on volatile organic compounds (VOC) for the Rail Link and other representative projects are presented in Table 4.

Table 4
Estimated Regional Air Quality Impacts of Rail Link and Selected Other Transportation Projects

	Capital Cost ($ millions)	Regional Reduction in VMT (miles/day)	Regional Percent Reduction in VOC	Capital Cost/ VOC Reduction (kg/year)
Rail Link and Electrification	3,400	366,000	1.26%	$12,000
Blue Line to Riverside via Huntington	900	71,000	.10%	31,000
Green Line to Medford Hillside	80	34,000	.05%	6,000
Commuter Rail to Worcester*	120	56,000	.08%	5,000

*Does not include the effect of increased train miles.

BENEFIT SUMMARY

The Central Artery Rail Link will provide numerous new transportation options to the residents of the Boston area, eastern Massachusetts, and New England by facilitating and providing a new higher level of rail service to Boston and the region. The benefits will fall into eight major areas as follows:

- Intercity rail service will be improved by eliminating the current rail system gap in downtown Boston and thus allowing through service to Maine and New Hampshire. Access to intercity rail services will be improved by providing direct regional rail access from all lines to intercity stations.

- Regional rail interconnectivity will be revolutionized by the operation of seven through-routed rail pairs as a true regional rail system oriented toward serving a wider array of mobility requirements rather than simple radial commuter trips.

- The inherent efficiency of run-through service as compared with the use of stub-end terminal trackage will effectively solve upcoming station track capacity problems at South Station.

- Core area trip distribution will be much improved with the rail link serving as its own trip distribution mode for many more trips. Easy direct connections to all four MBTA rail transit lines will provide many simpler transfer opportunities for regional rail patrons.

- Congestion levels will be reduced on the rapid transit system as shifts to the regional rail system take place. Some of the shifts will be for complete origin-to-destination commuter trips. Others will relate only to downtown distribution portions of trips.

- Air/rail connections to Logan Airport will be provided at South Station, with direct airport terminal access provided by the South Station-Logan Airport express bus. With the Rail Link, these connections will be available for all Amtrak and regional rail passengers. Blue Line access to the Airport will also be available to Amtrak and regional rail passengers via the new Rail Link Central Station.

- Highway/rail integration can be optimized through the creation of intermodal stations and activity centers at outlying crossing points of major highways and regional rail lines. These activity centers will act synergistically to maximize ridership and effectiveness of the regional rail system.

- Air quality improvement will be substantial due to the combined effects of reduced auto trips and rail system electrification.

3 Engineering and Construction

INTRODUCTION

This chapter examines the engineering and construction issues associated with building a Rail Link tunnel between Boston's North and South Stations. The geometric and spatial requirements of tunnels and underground stations are addressed in the context of existing infrastructure (buildings, transit, and roadways) and proposed facilities such as the Central Artery/Tunnel Project (CA/T) and the MBTA's Transitway and South Station Transportation Center (SSTC).

The concept of constructing the Rail Link in the Central Artery corridor as an intermodal project is being developed to take advantage of existing planning and design efforts as well as the anticipated economic savings that can be achieved by sharing the CA/T Project alignment between South Station on the south and Causeway Street to the north. **The proposed alignment, construction techniques and implementation strategy have no appreciable impact on the cost or construction schedule of the CA/T Project.**

A key element of alignment sharing is the provision of excavation support walls (ESW)[1] to facilitate construction of rail tunnels under the highway. To preserve the opportunity for either concurrent, or future, construction of the Rail Link under the Artery, these excavation support walls can be added to certain CA/T construction contracts as "deletive items" as early as the summer of 1993. (See Figure 11).

The total cost of these excavation support walls is estimated at approximately $92.3 million. About one-fifth of this amount ($20 million -- including approximately $1.5 million in nonrecoverable design costs -- would be required in 1993.) The remaining $60 million would be required by the end of 1995. Only the design costs are now at risk. If financing for the Rail Link is not available when the time for construction of the support walls actually arrives, this additional work could be deleted at minimal cost to the Commonwealth.

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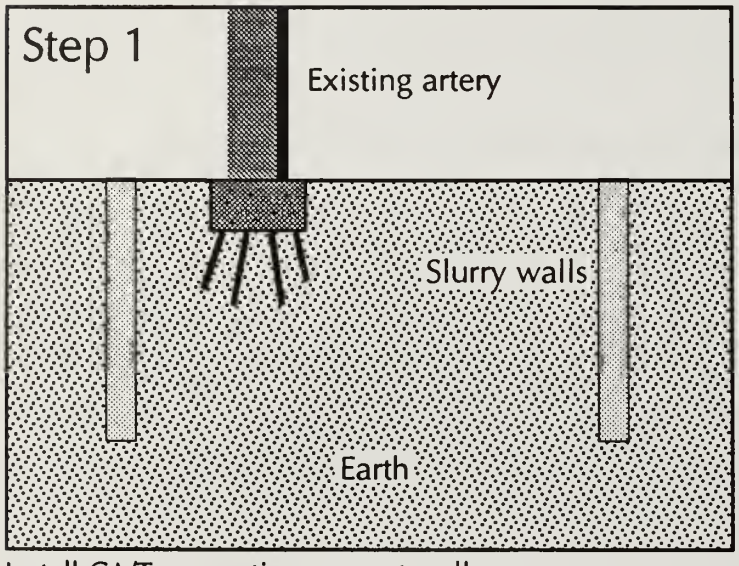
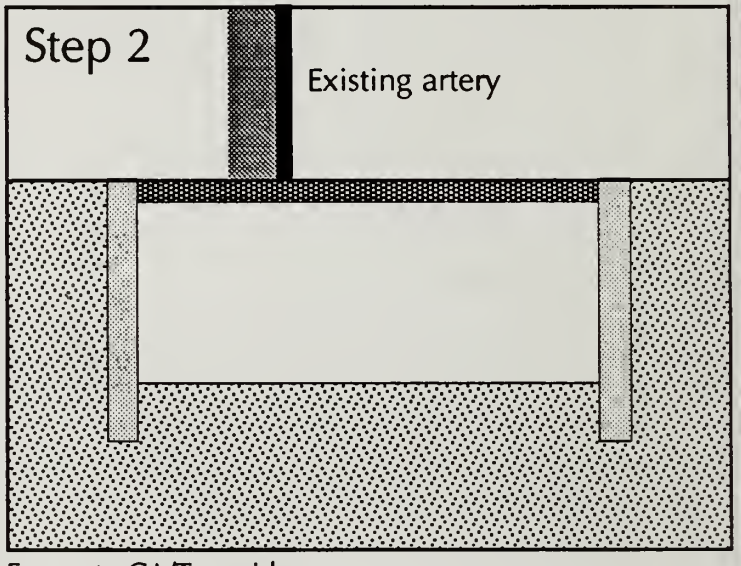
[1] Portions of the Rail Link beneath the CA/T will be built via mined excavation using the base slab of the highway as the roof of the Rail Link and the excavation support walls inserted when the highway was built for lateral support. The excavation support walls will stabilize the sides of the future rail tunnel providing protection against cave-in as the rail tunnel is constructed. The ESW's will employ slurry walls, soldier beams, or other similar shoring techniques as appropriate.

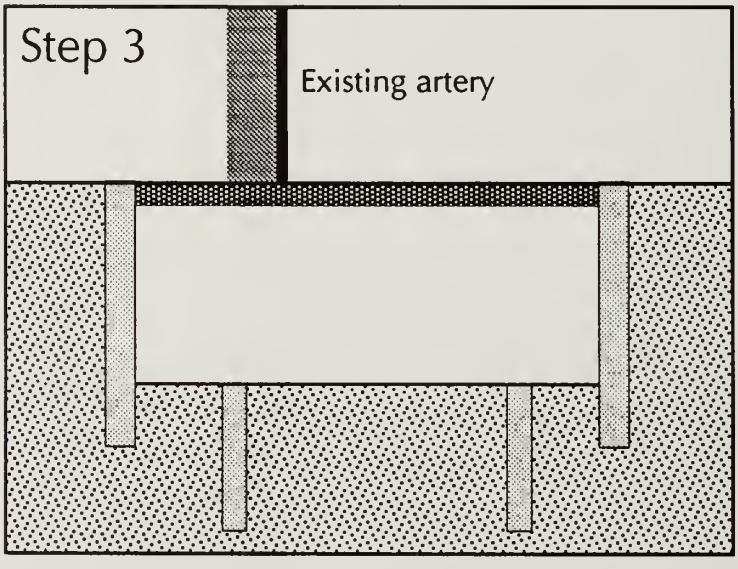
Figure 11
Proposed Construction Staging: CA/T Rail Link Interface



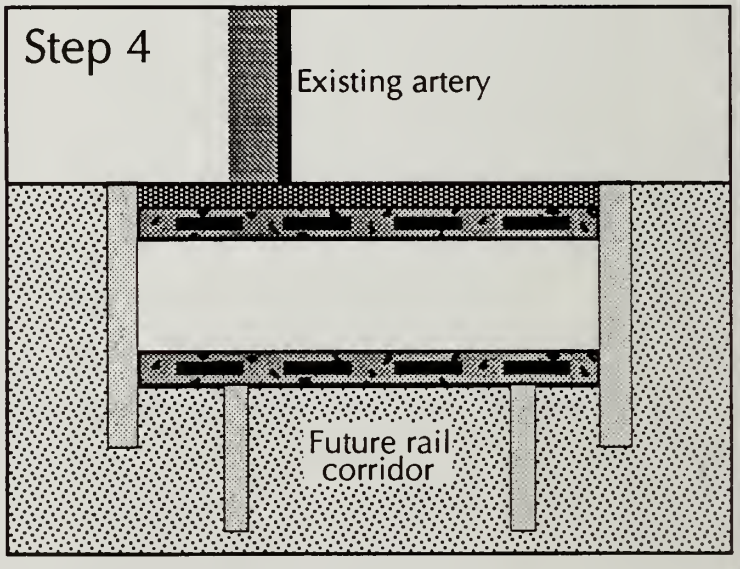
Install CA/T excavation support walls.



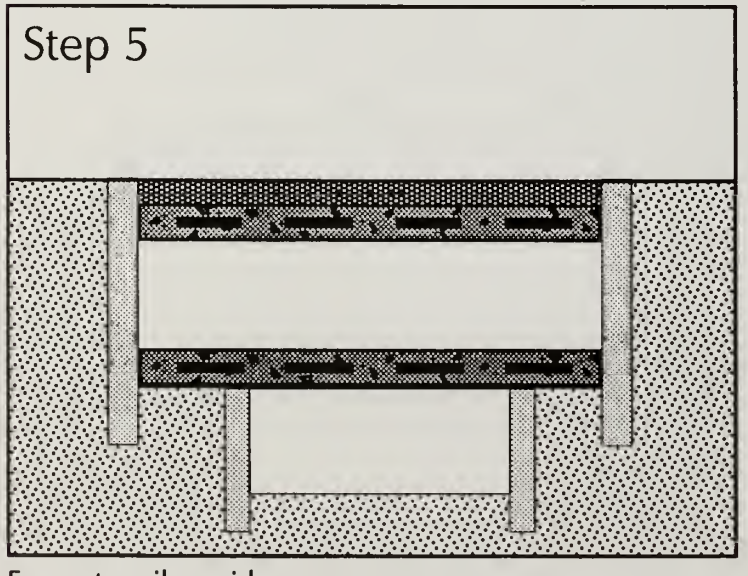
Excavate CA/T corridor.



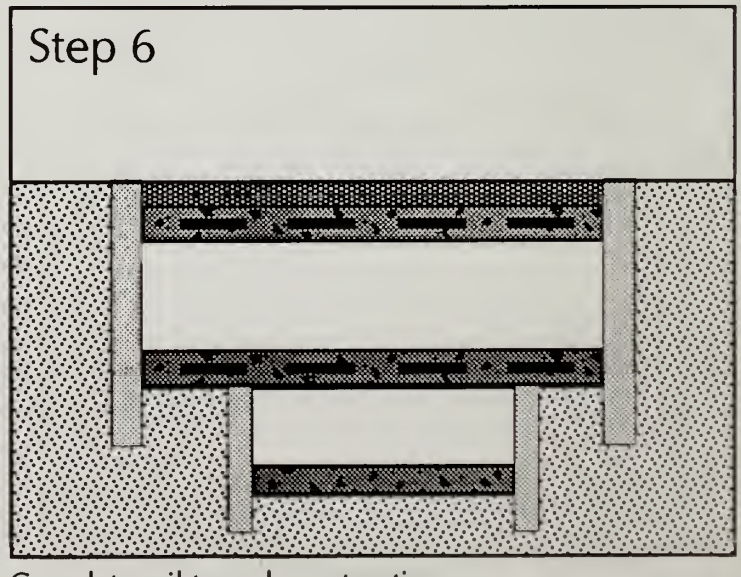
Install supplemental excavation suport walls for Rail Link.



Complete CA/T tunnel construction.



Excavate rail corridor.



Complete rail tunnel construction.

Source: Central Artery Rail Link Task Force

The objective of the CARL Task Force is to develop a Rail Link system within the Central Artery corridor which meets the following goals:

1. No impact to the Central Artery/Tunnel Project design and construction schedule.

2. Utilize construction efficiencies available to the Rail Link because of it's physical and schedule compatibility to the Central Artery/Tunnel Project.

3. Maximize intermodal connectivity with other transportation infrastructure (rail, transit, bus, auto) along its route.

4. Create a construction schedule for the opening of the Rail Link on a parallel schedule with the Central Artery/Tunnel Project.

DESIGN OPTIONS

Three design options were developed. Each is briefly described below. (For more detail see the technical appendices to this report.) All options provide a Rail Link tunnel system beneath the Central Artery/Tunnel highway structure in downtown Boston.

Option A---Option A was developed to provide surface-level connections to existing rail facilities at the South Station Transportation Center (SSTC). The engineering development of this option identified significant adverse impacts to both existing and planned infrastructure, including the MBTA's Transitway Project and MHD's Central Artery/Tunnel Project. Further development of Option A was, therefore, set aside and Option B.1 was developed.

Option B.1---Option B.1 was developed to minimize the design impacts associated with Option A. Its distinguishing feature is that it is "deep" at South Station. It passes under South Station. Consequently it includes a much lengthier tunnel system than Option A. This deeper alignment minimizes CA/T design impacts and provides an improved design interface between the Rail Link and the CA/T Project.

Option B.1, however, if constructed simultaneously with the Central Artery/Tunnel Project, would still tend to delay the CA/T construction program schedule. Consequently, further development of Option B.1 was set aside to allow development of an option that eliminated CA/T schedule impacts.

Option B.2---Option B.2's distinguishing feature is its construction timing relative to the CA/T Project. This schedule independence is provided by the creative use of excavation support walls (ESW), to be constructed with the CA/T Project. The ESWs will be vertical supports extending downward from the base slab of the highway tunnel to shore the walls of the rail tunnel against cave-in permitting relatively easy subsequent excavation of the rail tunnel using mining techniques.

This technique will facilitate construction of the Rail Link on an independent schedule. While the alignments for Options B.1 and B.2 are physically identical, the techniques and scheduling for B.2's construction serve to minimize it's impact on the CA/T Project construction schedule.

Recommendation: *Option B.2 meets the goals of the Commonwealth as outlined above and is the option recommended by the Task Force.*

Option B.2: Design Description

Starting from its northerly end, the Rail Link diverges from the regional rail system and descends into tunnel in the vicinity of the Gilmore Bridge in Cambridge, west of the I-93 highway viaduct. The Rail Link then descends under the Charles River immediately east of the existing commuter railroad draw bridge (Draw 1) before passing east of Boston Garden where is also passes under the existing Orange Line tunnel. At this point the Rail Link enters the CA/T highway alignment passing through the CA/T slurry wall(s) under the highway tunnel near the rapid transit tunnels south of North Station. A four track station will be built below and to the east of the planned new Orange and Green Line "Super-Platform" station. The station will provide a direct interface to the rapid transit lines and surface railroad station. From North Station, the Rail Link continues a fairly flat profile under the CA/T alignment. The highway overhead slowly rises until it passes over the MBTA Blue Line at State Street. The Rail Link passes below the Blue Line. A four track station with a direct connection to the Blue Line and pedestrian entrances at Quincy Market and International Place would be built immediately south of Aquarium Station.

The Rail Link then proceeds underneath the highway until approximately Congress Street where it turns through the CA/T slurry wall and leaves the highway alignment to enter South Station. It then proceeds under the South Station headhouse to an underground station platform constructed entirely below the South Station Transportation Center, currently under construction.

After leaving the underground South Station facility, the Rail Link begins to climb and splits, with appropriate crossing capabilities, into two branches. The first branch follows the existing Northeast Corridor along the southerly side of the Massachusetts Turnpike alignment, climbing to the surface in a two-track alignment between Harrison Avenue and Shawmut Avenue. The actual portal location will depend on final platform elevations as well as existing restrictions within this congested transportation corridor, which includes the Massachusetts Turnpike, Northeast Corridor/Framingham Line and MBTA Orange Line.

The Rail Link's second branch leaves the South Station platform and descends to the south beneath the existing Old Colony and Fairmont Lines, passing under the mud line of the Fort Point Channel, and under all existing and planned infrastructure improvements in the corridor of the I-90 (Massachusetts Turnpike)

extension. The Rail Link rises at a maximum three percent grade and portals at a location south of the Fort Point Channel. This portal will provide access to southside maintenance and storage facilities as well as ensuring interconnectivity between the commuter rail lines in southeastern Massachusetts and the Central Artery Rail Link.

Option B.2 and the CA/T Schedule

Option B.2 creates a rail link connection under the CA/T project highway tunnels without significant impact to the CA/T project design or construction schedule. The recommended option minimizes impacts in three ways.

- **Advanced Construction Features:** Option B.2 includes construction features to be implemented with the CA/T Project which will facilitate future construction of the Rail Link. These features include supplemental excavation support walls, which, when constructed with the CA/T Project, will aid the construction of the Rail Link. The cost of these features is approximately $92.3 Million[2]. They can be constructed in the CA/T corridor at the time of the CA/T Project without significant impact to the CA/T Project construction schedule. Refer to Table 5 for a summary of these features (modifications) and issues associated with their implementation.

- **Construction Timing:** Option B.2 uses construction methods which permit the Rail Link to be constructed following the CA/T project in areas where the highway is scheduled for early construction, such as contract C11A1 (between Kneeland and Oliver Streets - Northbound only) and contract C17A2 (between Central Station and the entrance to the Callahan Tunnel). Refer to Figure 12 for possible construction staging.

- **Independent Construction:** Much of the Option B.2 design (North of Causeway Street and South of Congress Street) does not encumber the CA/T construction project and will be constructed separately on an independent schedule.

Between Causeway and Congress Streets, much of the Rail Link tunnel uses the highway's invert (bottom) slab as its roof structure. In this section the Rail Link will be constructed using mined tunnel techniques between the excavation support walls built to construct the highway tunnel. In several locations these walls will need to be supplemented or extended to help support Rail Link construction. Of the several locations where this supplementary support wall construction is anticipated, the most schedule sensitive location is in CA/T contract C17A2 which extends from Central Station to North Street.

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2 Including $7.1 million for design.

Table 5

Central Artery/Tunnel - Rail Link Interface

Advance Construction Items

CONTRACT NUMBER	DESCRIPTION OF MODIFICATION	CA/T PROJECT ACTIONS NEED DATE	COST OF MODIFICATION CONSTRUCTION (2)	COST OF MODIFICATION DESIGN (2)	REMARKS
C11A1	None	N/A	None	None	Bore through 11A slurry walls.
C17A1	Extend slurry wall below bottom slab or additional wall(s). (1)	Jan 95 (9 mos)	$29,600,000.00	$2,500,000.00	Need date based on change to C17A1 PS&E prior to advertisement.
C17B1	Revise transverse bulkhead walls in order to bore through later.	Nov 93 (6 mos)	$1,200,000.00	$100,000.00	Need date based on change to C17B1 PS&E prior to advertisement.
C17A2	1. Deletive item(s) – wall(s) OR	See note (4)			Need wall design info. prior to ADV date.
	2. Contract mod. – additional wall(s)	Nov 94	$18,200,000.00	$1,500,000.00	Need change order within 12 mos. of NTP
	3. Shield – driven tunnel	N/A	None	None (3)	Further technical evaluation needed.
C15A1	Extend slurry wall below bottom slab or additional wall (s).	Jan 95 (10 mos)	$18,100,000.00	$1,500,000.00	
C15A2	Extend slurry wall below bottom slab or additional wall (s).	Jan 95 (13 mos)	$18,100,000.00	$1,500,000.00	
		TOTAL =	$85,200,000.00	$7,100,000.00	

NOTES

(1) Cost and schedule evaluation assumes a combination of supplemental wall(s) and wall extensions. Future final design will define actual needs.

(2) Costs are assumed NOT to be borne by the CA/T Project.

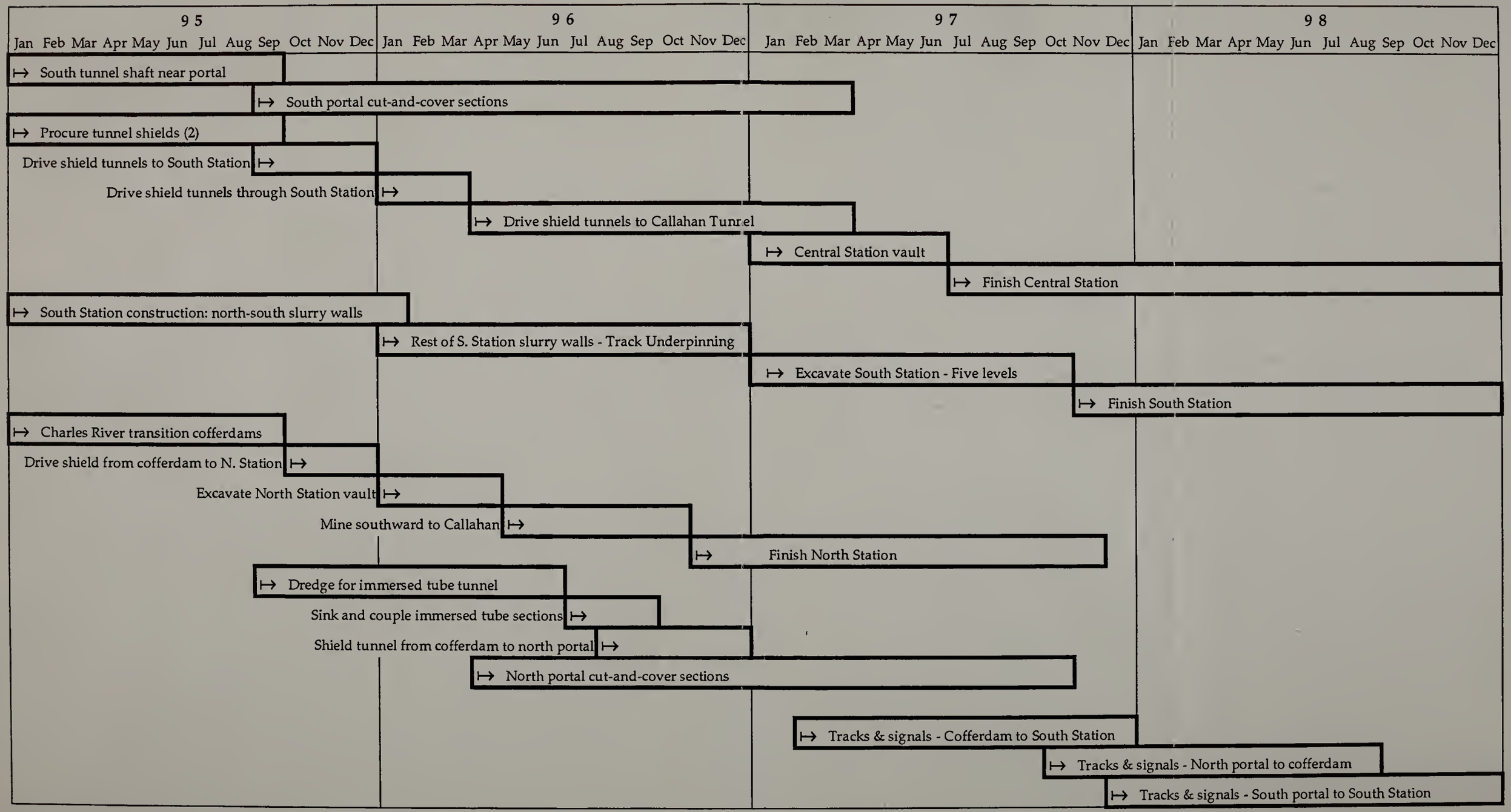
(3) No additional cost to CA/T Project, but the estimated Rail Link cost may increase with shield – driven tunnel construction technique.

(4) Based on a C17A2 advertisement date of July 15, 1993, approximately 8 weeks are available for the design and implementation (into the C17A2 PS&E) of this modification as a deletive item, assuming the process begins on May 15, 1993.

Source: Central Artery/Tunnel Project

Figure 12

Possible Construction Staging: 1995 - 1998



Source: Central Artery Rail Link Task Force

Note: This figure shows a logically sequenced construction program for the Rail Link's major civil engineering elements (tunnels, stations, etc.). Actual construction timing of the Rail Link will depend upon environmental reviews and approvals as well as the timing of Northeast Corridor electrification, the Central Artery/Tunnel Project, MBTA capital improvements, and potentially other major projects.

Contract C17A2 is currently nearing its construction advertising date and will require some modifications to provide for the excavation support walls (ESW) below the highway. In order to design the ESW under this construction segment, the rail alignment must be established with sufficient tolerances to not adversely affect the highway if the rail alignment is revised at a later date. The Rail Link alignment and ESW design must be made final as soon as possible. The extended ESW will be constructed by the CA/T Project contractor as part of the C17A2 construction program. With the ESW in place, the rail tunnel can be constructed independently.

CONSTRUCTION METHODS

Construction of the Option B.2 Rail Link tunnel and stations will employ a variety of construction methods listed in the table below.

Table 6
Construction Methods

Construction Method	Rail Link Application	Depth Range (Feet)
Open Cut "Boat"	Surface Portals	0-25
Cut & Cover	Approach to Portals	25-60
Shield driven[3]	New Tunnel	60-200+
Mined Tunnel	Under CA/T	NA
Immersed Tube	Charles River Crossing	NA
Top Down	South Station	NA

Schematic sketches and proposed locations for all segments are shown in Figure 13 and in the technical appendices to this report. A summary description of how the Rail Link will be constructed is provided below. A more detailed description outlining assumptions, decision rules, alternative comparisons and other considerations can be found in the technical appendices.

Construction Segments---Option B.2 tunnel and stations will be built in at least nine distinct segments allowing for several simultaneous construction projects. Proposed construction for each of the basic segments is outlined below.

Segment 1 (South Portals to South Station)---Beginning at the Back Bay Portal on the Northeast Corridor and and at the Southampton Street Portal in South Boston, construction team(s) will construct tunnels using open cut (boat) and cut and cover techniques. Upon reaching the depth of approximately 60 feet, boring equipment will be employed to drive a 2-track tunnel for each branch. Where the two branches converge, a 4-track shield-driven tunnel will be

3 The terms "shield-driven" and "bored" are used interchangeably in this report.

bored. The rail tunnels will be driven as individual tubes or in pairs (binocular configuration) depending on the geometry. The four track bored tunnel will continue under South Station at depths approximately 90 feet below the surface. Under South Station the bored tunnels will be used to set the inverts for the new subterranean station to be constructed above and around the tunnels and to provide early access for the excavation of segments further north.

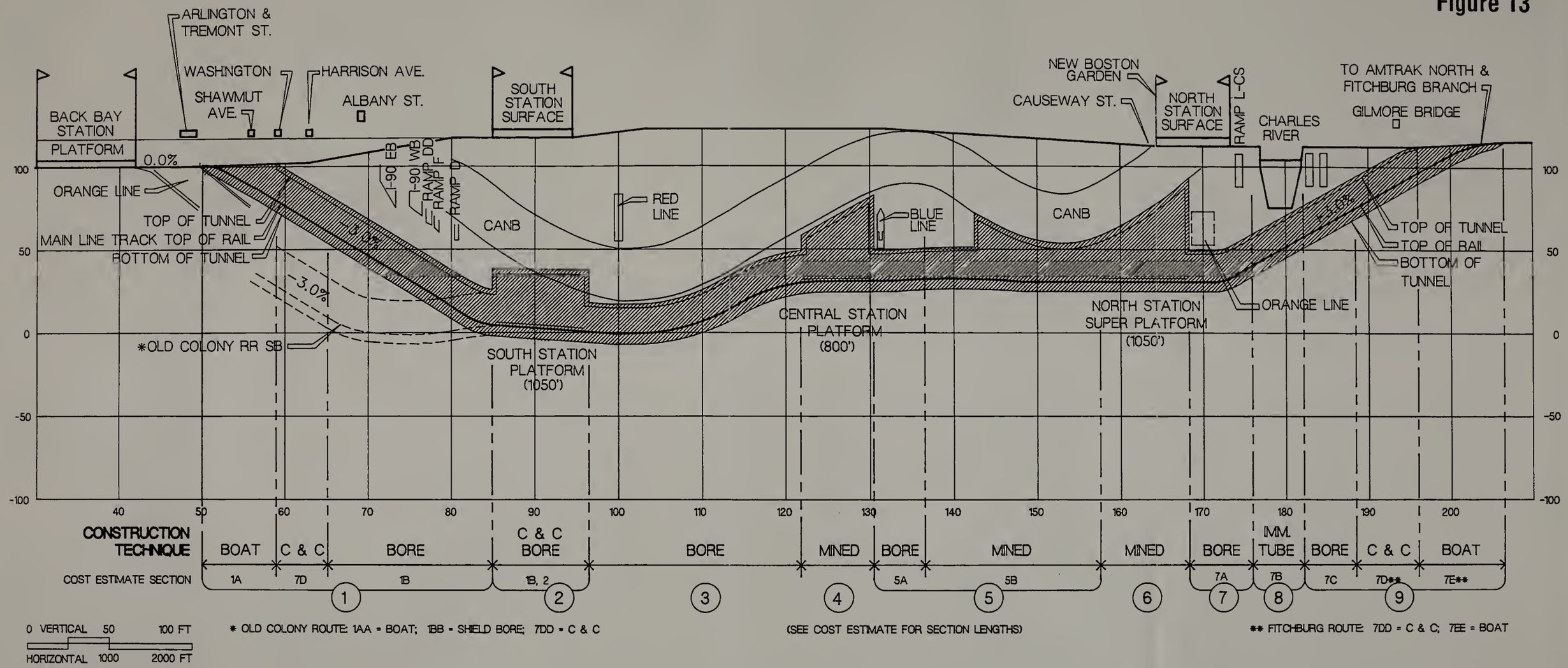
Segment 2 (South Station)---The 1,050' long station will be built using perimeter slurry walls and mining techniques to create a new station under the existing railroad platforms. The existing surface track station platforms will require underpinning while the "top-down" station construction progresses. Once the South and North slurry walls have been completed, four "pilot tunnels" will be driven through the station site, to allow for an early start on Segment 3. The subterranean South Station will have escalator and elevator access to the surface railroad station, the Red Line and the South Boston Transitway.

Segment 3 (South Station to Central Station)---A 4-track tunnel will be bored beneath the South Station. It will move beneath the CA/T tunnels at approximately Congress Street. It will then continue under the CA/T to Broad Street which will be the southerly end of the new Central Station. Along this segment, the base slab of the highway tunnel is too high above the Rail Link alignment to allow it to be used as the roof of the rail tunnel. (At this point the highway tunnel is rising to go over the Blue Line tunnel while the Rail Link is remaining deep to go under the Blue Line.)

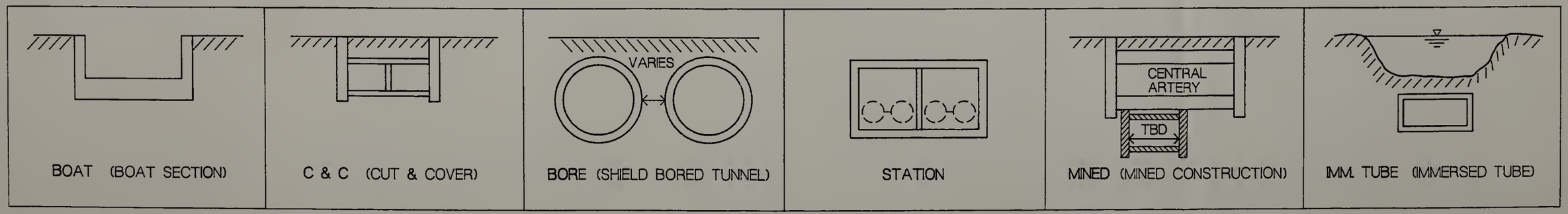
Segment 4 (Central Station)---Central Station will be mined from between ESWs provided by the highway tunnel's construction. The highway base slab will serve as the roof structure for the new rail station below. Central Station will be an 800' long 4-track station with direct access to the Blue Line and pedestrian egress to Quincy Market, International Place and Rowe's Wharf.

Segment 5 (Central Station to North Station---This segment will be built using two different techniques. First, the northern boundary of Central Station will be the southern limit of the present Blue Line tunnel. To avoid potential problems with undermining the rapid transit tunnel, the Rail Link will pass under the Blue Line with a shield bore tunnel. The shield bore tunnel will be used northward until the base slab of the highway is low enough to allow highway floor to economically serve as the railroad's roof. Once the highway and Rail Link converge, mining techniques using ESW's provided by the CA/T will be employed to excavate the Rail Link northward to the subterranean North Station.

Figure 13



CONSTRUCTION LEGEND



PROFILE OPTION "B2"

PROPOSED NORTH/SOUTH STATION RAIL LINK

Source: Central Artery Rail Link Task Force

Segment 6 (North Station)---The new 4-track North Station will be mined under the CA/T highway tunnel using the same techniques employed for Segments 4 and 5. The subterranean North Station will provide direct connections to the Orange and Green Lines as well as escalator and elevator access to the surface, the railroad station and the Garden.

Segment 7 (North Station to Charles River)---Immediately north of the North Station platforms, the Rail Link tunnel will penetrate the western CA/T slurry walls using a shield bored tunnel technique. The four track shield bore tunnels will continue to a cofferdam on the south bank of the Charles River immediately downstream of the railroad drawbridge.

Segment 8 (Charles River Crossing)---Cofferdams will be installed on both banks of the Charles River and prefabricated immersed tunnel tubes will be installed in the river bed to provide a four track subaqueous crossing of the Charles.

Segment 9 (North Portals to Charles River)---There will be two North portals: one for traffic to Portland, Haverhill Lowell and the North Shore; the other to the storage yards and the Fitchburg service. Starting from the two portals, the construction team will construct tunnels using open cut and cut and cover techniques. The two tunnels will converge in the cut and cover section. Upon reaching the depth of approximately 60 feet, boring equipment will be employed to complete the 4-track tunnel to the coffer dam on the north bank of the Charles River.

Construction Packages---As design and construction planning for the Rail Link evolves, the construction methods described in this report will be refined in technique and location. At this time it is expected that the overall tunneling project could be broken into five independent subprojects:

1. South - South Portals to Central Station (Segments 1-4)

2. South Station - Top down approach (Segment 2)

3. Central - Charles River to Central Station (Segments 5-7)

4. Charles River Crossing - Segment 8

5. North - North Portals to Charles River (Segment 9)

In segments where the Rail Link and the CA/T share the right of way (Congress to Causeway) the CA/T elements will be under construction or complete, before rail tunneling begins. After highway construction is complete in joint use areas the two projects will be virtually independent.

CRITICAL ELEMENTS

South Station is on the critical path because it is a major construction project and because the construction access to build Central Station and its Rail Link connection to the south will be via South Station. Therefore, South Station presents a difficult problem from both a schedule and construction viewpoint. There are proven construction techniques available for this depth of construction. In this case, very close coordination of construction and track use will be required. In the schedule, 12 months have been allotted to complete the two end slurry walls (270 linear feet) crossing the tracks. An additional 12 months, for a total of 2 years, has been allotted to complete the slurry box and underpin the tracks. Based on previous similar construction in Boston, an allowance of 10 months has been allotted to excavate and place the supporting floors for a total of 34 months to reach the bottom floor of the station structure.

If the boring operations for the tunnels north of South Station to the new Central Station were to await completion of the excavation at South Station, possibly 18 months would be lost. To expedite the work north of South Station and south of the Blue Line, twin tunnels will be driven northward through the end slurry walls of South Station and under the Central Artery. Construction of the South Station end slurry walls thus becomes extremely schedule critical. A favorable by-product of this sequence allows the excavation products from South Station to be removed through the tunnels to avoid congested city streets.

Constructing Option B.2 north of the Blue Line and North Station is less critical from a schedule viewpoint. Access to North Station from the south transition cofferdam of the immersed tube is shorter and simpler, and there appears to be some schedule float in this portion of the project.

IMPLEMENTATION STRATEGY: OPTION B.2

This section outlines strategies which can be employed to build Option B.2 in the CA/T project alignment without affecting the highway construction schedule. As stated previously, the conceptual Rail Link alignment and the construction methods described earlier were developed to take advantage of construction efficiencies available to the Rail Link due to its physical and schedule compatibility with the Central Artery/Tunnel Project. However, the CA/T Project is farther advanced than the Rail Link, with two mainline tunnel construction contracts within the shared corridor scheduled for advertising during 1993. Several other contracts are scheduled for advertisement within the time necessary to secure environmental approvals and complete Preliminary Design. However some of these construction packages will require lengthened ESWs to provide for the economical construction of the Rail Link, while not affecting the Central Artery construction schedule. These ESWs can be designed and incorporated into the highway contracts, as deletive items, and constructed as part of the CA/T Project (See Table 5) as it progresses.

As proposed, the Rail Link shares the CA/T Project alignment between Summer Street and Causeway Street. Within this area the following CA/T construction packages will have varying degrees of interface with the Rail Link:

C11A1 - Kneeland Street to Oliver Street - Northbound Only
C17A1 - Oliver Street to Central Station
C17B1 - MBTA Aquarium Station
C17A2 - Central Station to Entrance to Callahan Tunnel
C15A1 - Callahan Tunnel to New Sudbury Street (Haymarket)
C15A2 - Haymarket to New Boston Garden

Table 5 and Figure 14 provide more detail on the construction packages. Two of these packages are scheduled for bidding in 1993.

C11A1: Kneeland to Oliver---The first CA/T construction package is scheduled for advertising in July of 1993. However, since the Rail Link construction method proposed does not require any change to this contract, it can be advertised as scheduled.

C17A2: Oliver to Central---The next CA/T construction package scheduled to be advertised will be the mainline tunnel between State Street and North Street. In this package, the Rail Link is aligned directly beneath the highway tunnels. To take advantage of potential construction efficiencies in this area, additional excavation support walls (ESWs) can be added to the CA/T design to allow for the future construction of the Rail Link using mining techniques (See Figure 3-1). At this time the estimated cost of these additional walls is $18.2 million.

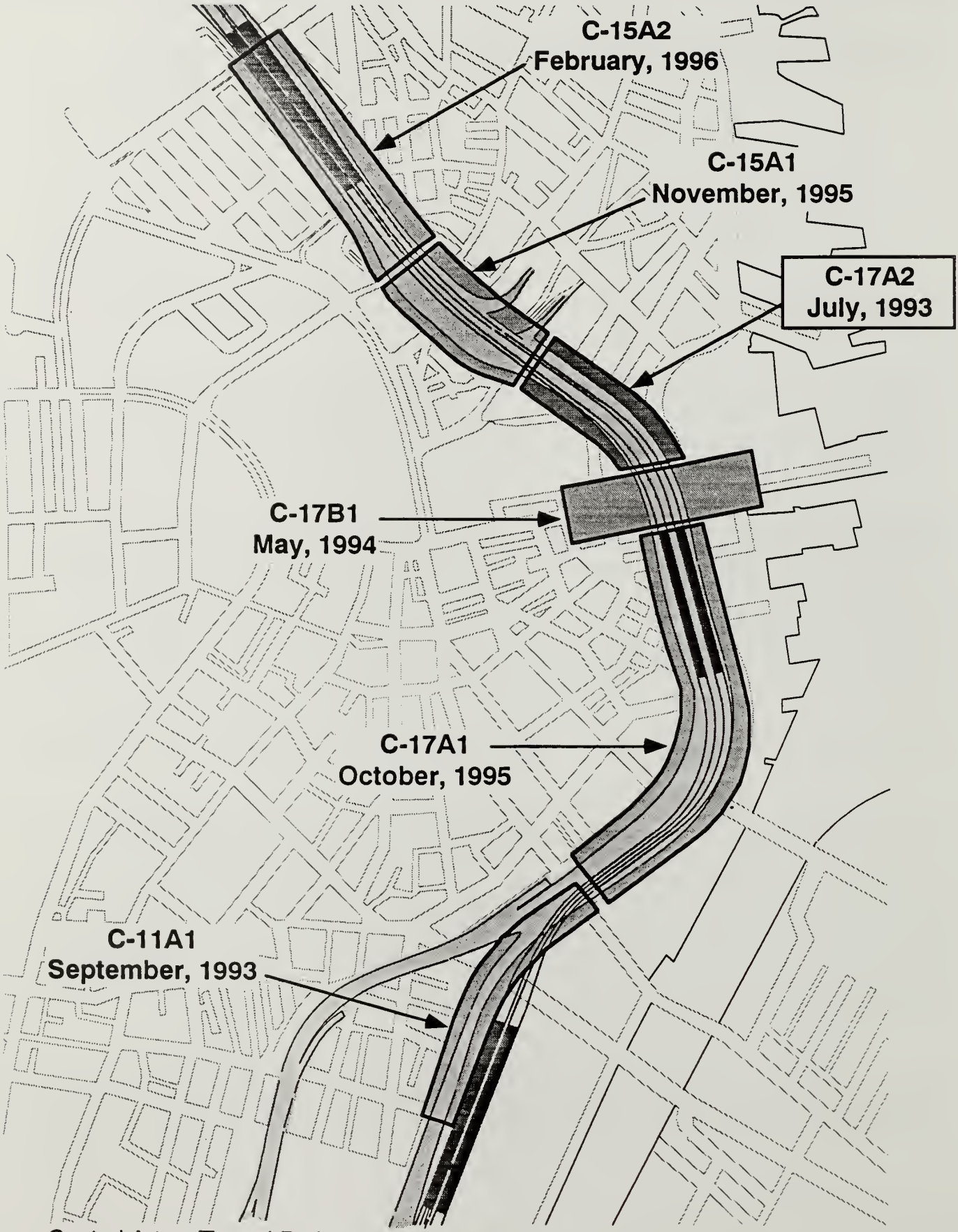
Three strategies are available to make provisions for the Rail Link within the C17A2 CA/T construction package:

Strategy 1---Excavation support walls below the highway base slab designed in the C17A2 package can be included in the bid documents as "**deletive items**", prior to advertising. This strategy is attractive because it provides considerable construction cost savings over other approaches. The "deletive item" strategy permits the CA/T construction contract to be completed without the Rail Link elements at the time of construction with minimal cost penalties. In addition, this action will make a clear statement about the Administration's commitment to the implementation of a Rail Link. Under this strategy, the additional $18.2 million for construction would need to be obligated at the time of advertising.

Approximately $1.5 million for the design changes necessary to include the additional excavation support walls in the construction package must be committed immediately. This strategy would also require the Rail Link design team to establish

Figure 14

Construction Contracts/Advertising Dates



Source: Central Artery/Tunnel Project

the ultimate rail alignment at this early stage of project development.[4] This option requires an immediate decision to modify the relevant design contract (D017A2) based on current Rail Link conceptual design development.

Strategy 2---The C17A2 package could be advertised for construction bids as scheduled by the CA/T Project with no changes to accommodate the Rail Link. The excavation support walls for the Rail Link, if desired, could be added as "extra work" with a construction contract modification at a future date consistent with the CA/T construction schedule.

The advantage of this approach is that it allows greater design development of the Rail Link before committing to the location of the supplemental excavation support walls.

The disadvantage of this approach is that there will be a cost premium if supplemental walls are added to the construction contract following the competitive bid process.

Strategy 3---A third "**do-nothing**" option exists for the interface of the CA/T C17A2 construction package and the Rail Link. This highway package, and other packages providing opportunities to support the rail tunnel, could be completed without adding additional elements for the Rail Link. Rail tunnels would then be constructed using a shield-driven tunneling method at a later date. The cost of this technique would be significantly greater than that of either of the previously listed strategies, and contains uncertainties in terms of construction due to the variable geologic conditions.

Subsequent Construction Packages---All other CA/T construction packages that interface with the Rail Link (C17B1, C17A1, C15A1, C15A2) are scheduled for construction considerably later than the two discussed above. The first, C17B1, is scheduled for advertising in May 1994, while the rest would not be advertised for construction before October, 1995. The total estimated cost of the design modifications to these packages is $5.6 million with a total construction cost estimated at $67 million. The supplemental excavation support walls and any other elements could be added as "deletive items" similar to Strategy 1 for C17A2. This would allow for their deletion at little risk of cost penalty should Rail Link construction not proceed. The timing of these CA/T construction packages also allows greater design development of the Rail Link, thereby reducing the risk of committing to a less than optimal rail alignment.

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[4] It should be noted that the contract package could be structured to allow minor modifications to wall locations after contract award, thereby allowing time to resolve some of the uncertainties inherent in all conceptual designs.

Rail Link Schedule---In order to be completed as soon as possible the Rail Link design and construction must proceed on an ambitious schedule in coordination with the CA/T Project. Key milestones over the next 18 months are listed below.

Table 7
Early Action Items

Task/Milestone	Start	Finish
Notice to Proceed (NTP)	July 1993	-
EIS Studies - Engineering	August 1993	April 1995
Modification of CA/T Contracts	August 1993	December 1995
Groundbreaking	January 1995	-

The proposed construction schedule for 1995-1998 is shown in Figure 12.

IMPLEMENTATION COST: B.2

CA/T Costs---This section summarizes the costs of ESW design and construction that would add to cost of the CA/T in order to facilitate Option B.2. The cost of these features has been estimated at $92.3 million (See Table 5). Approximately $20 million would be necessary in 1993 for implementation of C17A2. The remainder would be obligated through 1995 for the balance of the interface packages.

Rail Link Costs---The bulk of the Rail Link costs would support the independent Rail Link construction schedule. This schedule will depend on available financing as well as project development including design, environmental analysis, and construction permitting.

Conceptual level cost estimates for the provisional elements and the Rail Link as a whole have been developed utilizing unit costs which reflect current (1993) Boston area construction costs. Lump sum costs for which detailed units are not available are based on construction experience, judgment, knowledge of local conditions, and local construction requirements. The cost estimate for full implementation of Option B.2 from portal to portal with all four tracks, three underground stations, ventilation structures, and power supplies for the four tunnel tracks is approximately $1.7 billion. Detail on the development of this cost estimate is provided in the technical appendices to this report.

4 From Concept Plan to Operating Reality

INTRODUCTION

This chapter addresses critical elements and sequences of events necessary to transform the Central Artery Rail Link from a planning study into an operating reality. In designing a plan for action, three aspects of the project are of prime importance:

- The Rail Link is conceived to be built in conjunction with the Central Artery/Third Harbor Tunnel project which has been in planning and design for at least a two decades, and is at a critical juncture in its own life cycle. Time is of the essence since there is a narrow window of opportunity for the two projects to enjoy cost and construction efficiencies from cooperation.

- The project is expensive and will require substantial funding.

- The project needs to be phased so that the Rail Link tunnel can begin returning transportation benefits long before the overall project is complete.

With these three considerations in mind, this chapter discusses the near-term requirements or "critical elements" necessary to develop and sustain project momentum, and carry the project through Phase 1, the first of two major phases of construction. Phase 1 will include completion of two tracks of the main Rail Link tunnel, with implementation of through intercity service between New York and Portland, and of electrified regional rail service between Providence and Haverhill, and between Stoughton and Lowell. Phase 1 will take place between now and the year 1998, and it is anticipated that it will cost approximately $1.85 billion.

Phase 2, the second project phase, will involve expanding the Rail Link tunnel to four tracks and developing additional electrified regional rail services running through the Rail Link. Completing Phase 2 will provide the balance of the interconnections and intermodal benefits desired by New England and the Commonwealth. Phase 2 is expected to cost an additional $1.78 billion, and will be built over a number of years during the earlier part of the Twenty-First Century.

CRITICAL NEXT STEPS

In order to move rapidly toward Rail Link implementation consistent with the Artery construction schedule, the Task Force has identified four critical steps that should be taken now. These include preparations for supplementary slurry wall construction under the Central Artery, securing initial funding, conducting environmental analysis, and undertaking preliminary design/engineering.

1. Supplementary Excavation Support Wall Construction. Building the Rail Link in the Artery alignment requires that supplementary deeper excavation support walls be included in the construction packages to be advertised in mid-1993. These walls will allow later Rail Link construction while leaving the Artery construction schedule unaffected. The Task Force recommends separate funding for the design and construction of the supplementary support walls, independent of Artery finances. In order to retain complete flexibility, it is recommended that the supplementary walls be included in the construction packages as items which can be deleted (deletive items) at minimum cost to the Commonwealth in the event that separate funding is not made available for the Rail Link.

   Developing the political and institutional support to effect this strategy within the time available is an immediate task. Vigorous support is required from the highest levels in the state and federal governments.

2. Funding. During Phase 1 (1993-1998), funding in the amount of $1.85 billion will need to be secured for design and construction of the Rail Link in the Central Artery Corridor, and for electrification of the regional rail lines between Providence and Haverhill, and between Stoughton and Lowell. Immediate funding is necessary to continue design, begin environmental analysis, and allow initial construction of supplementary excavation support walls. It is anticipated that at least some federal funding will be provided through Amtrak for the Rail Link and for the extension of electrification as part of the Northeast Corridor Project.. It is recommended that the task of financing, building, and operating the Rail Link be accomplished by means of a public/private consortium consisting of the MBTA, Amtrak, and private financial partners.

3. Environmental Analysis. Because the Rail Link and the associated intermodal regional rail service network will be significant transportation investments, environmental analysis and an Environmental Impact Statement (EIS) will be required. It is the understanding of the Task Force that an EIS can be developed concurrently with preliminary engineering. It should be expected that at least eighteen months will elapse from the project start date until all environmental studies and preliminary engineering for the Rail Link can be completed.

4. Preliminary Design/Engineering. It now appears that design/engineering will take place in five separate packages involving different segments and elements of the project as follows:

   - Back Bay Portal to State Street
   - State Street to North Station (under the Artery)
   - North Station to North Portal
   - Track and Signal
   - Boston-Portland Electrification (Phase 1 to New New Hampshire line, initially)

   It is anticipated that these project elements will be designed concurrently, and that preliminary design/engineering will make provisions for both phases of the project. In particular, Phase 1 engineering must include plans for development of the Phase 2 tunnel, including its track and surface improvements.

   In order to carry out the Phase 1 design and engineering, as well as its associated environmental analysis and subsequent engineering and construction, the Task Force recommends that a Rail Link Project Office be created to operate in close coordination with the existing Central Artery/Tunnel project Design Team under the direction of the Executive Office of Transportation and Construction. It is anticipated that this Rail Link Project Office will have significant participation from the MBTA and Amtrak.

FOLLOW-UP STEPS

As soon as Rail Link preliminary design elements are completed, work on corresponding final designs will begin. Including final design, later steps in Rail Link implementation will take place as follows:

1. Final Design. The final design process takes projects from 30% design completion to the 100% level, and includes preparation of construction documents. Final design packages will be completed to be in accord with stages of construction which will expedite the construction process, and coordinate with Central Artery construction.

2. Construction. It is expected that construction will be broken into several packages for contracting and completion. For instance, construction for each of the subterranean stations could be done with a separate contract. Various segments of the tunnel could also be built as separate contracts. Work on track, switches, signals, and catenary could be completed rapidly under separate rail specialty contracts after tunnel completion but before opening the tunnel to traffic. (See Chapter 3.)

3. Commuter Rail Electrification Project (CREP). After Phase 1 is complete, a substantial project will remain to electrify the remaining lines that will be routed through the tunnel. Work on signals, bridges, other structures, track, and stations will be required in addition to the catenary and power supply elements of the project. It is suggested that a separate dedicated project team working under the direct control and supervision of the MBTA be assembled for this project. It is expected that the CREP will be a 20 year undertaking. The most cost effective way of pursuing the project will be to use a separate team working on force account basis to provide support for engineering and to conduct the installation of power and signal improvements.

4. Equipment Procurement - The Rail Link intercity/regional rail project will require the acquisition of approximately 80 electric locomotives and 150 coaches over a 15 year period. This procurement can be made in the same time frame as a large rail electrification project now taking shape in Southern California. If these two projects can coordinate equipment specifications and procurement, there will be economies of scale. *Rolling stock presents a manufacturing and assembly opportunity for the private sector in Massachusetts and New England, and may provide means to participate in Federal defense conversion programs.*

5. Support Facilities - New support facilities for the Rail Link and electrified regional rail system will include a control center for train and power dispatching as well as equipment and facilities to maintain and support electric traction equipment and power supply apparatus.

6. Maintainability Engineering - The level of service expected from the regional rail service using the Rail Link will require a somewhat higher level of reliability than currently provided. In the process of designing the Rail Link, the regional rail network, and the support facilities necessary to provide the service, constant attention must be paid to the maintenance philosophies and programs which will be required to sustain high service levels. Systems must be designed with maintenance and reliability in mind. Programs for proactive and aggressive preventive maintenance of physical plant (particularly switches, signals, power and communications) and rolling stock (particularly motive power) will be designed as the system is conceived and considered in the light of the overall operation.

7. Operating Liaison and Operations Planning - It is expected that the needs of the railroads (Amtrak & MBTA) and the environment within which they operate will change over the length of time necessary to complete this project. With this in mind, a flexible plan has been recommended. Nonetheless, a continuous process of reaffirming and adjusting the operating assumptions of the Rail Link and the intercity/regional rail system is essential to ensure that the facilities delivered are most appropriate for the specific applications required on delivery dates.

CONSTRUCTION PHASES AND COSTS

Phase 1: New York-Portland, Providence-Haverhill, and Stoughton-Lowell Service (Completion: 1998). In order to achieve Rail Link operations by the earliest possible date at minimum cost, Phase 1 will extend the Northeast Corridor from Boston to Portland by providing a two-track Rail Link from Back Bay to North Station, and an extension of Northeast Corridor electrification from South Station to Haverhill (see Figure 15). Amtrak will be able to provide continuous through service from the New Hampshire state line to New York and points south. (Eventually the privately owned trackage in New Hampshire and Maine could be electrified.)

The MBTA regional rail service will use the electrified route along the Northeast Corridor and the Rail Link to provide through service from Providence to Haverhill along the MBTA "A" line. In addition, Phase 1 will also include electrified regional rail service on the MBTA "B" line from Stoughton to Lowell. The Stoughton-Lowell "B" line route will be included in Phase 1 service because of the substantial joint use of Providence-Haverhill "A" route trackage by the Stoughton-Lowell route.

In order to implement Phase 1 services, the following facilities will be constructed:

- The Rail Link tunnel under the Central Artery with two tracks (with expansion capacity to four tracks).
- Three subterranean stations: North, Central, and South.
- Portals to Back Bay and Southampton Street (south) and Somerville (north).
- Electrification along the "A" line northward at least as far as Haverhill (and preferably Portland)[1] .
- Electrification along the "B" line from Wilmington to Lowell and from Canton Junction to Stoughton.

The cost of the two track Rail Link tunnel and stations, and the cost of electrifying the 72 track miles between Boston and Haverhill will be federal Northeast Corridor expenses. The cost of new electric MBTA rolling stock and electrifying the 24 track miles from Wilmington to Lowell, and from Canton Junction to Stoughton, will be state expenses.

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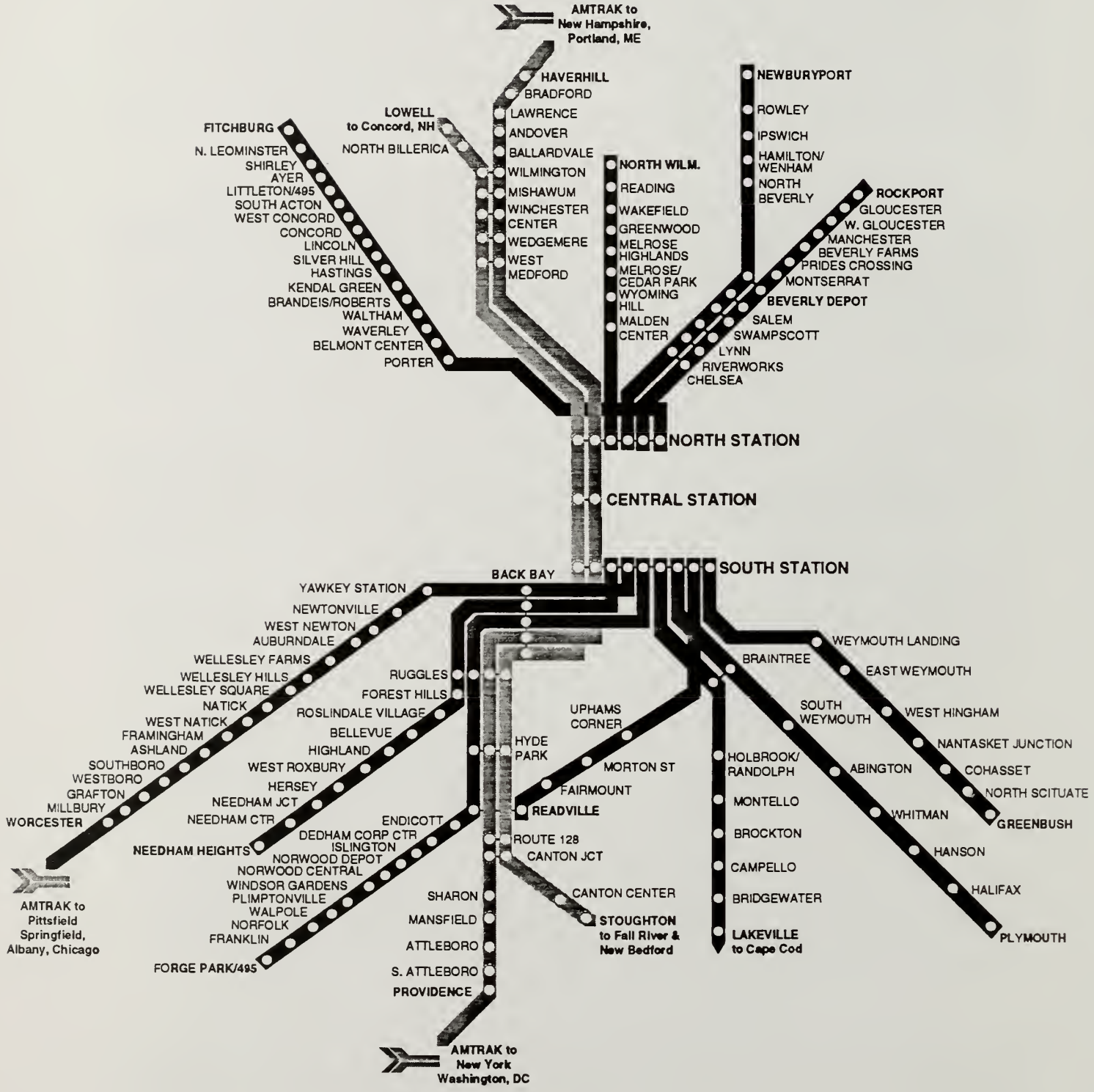
[1]Extending electrification 82 miles from Haverhill to Portland would cost approximately $150 million for catenary and power, and for signal improvements. No costs have been developed for increasing bridge clearances or for additional rolling stock or other improvements for the Portland electrification extension.

Figure 15

Regional Rail Network Schematic: 2002



Source: Massachusetts Bay Transportation Authority

An approximation of the overall budget for Phase I is shown in Table 8.

Table 8
Rail Link Phase 1 Budget
1993-1998

Component	Cost (Millions)	NEC Cost	MBTA Cost
Tunnel & Station[2]	$1,319	$1,319	
Surface Improvements	$282	$232	$50
Added MBTA Rolling Stock	$252		$252
TOTAL	**$1,853**	**$1,551**	**$302**

The Phase 1 system will provide the mechanism to convey virtually all of the intercity rail passenger benefits of the Rail Link and electrification. The increase in regional rail ridership with the Phase 1 system will be approximately 40% of the increase expected with completion of Phase 2. Expectations concerning benefits should be scaled accordingly.

Phase 2: Entire Regional Rail System (Completion during first quarter of 21st Century). Phase 2 will largely be a multi-year commuter rail electrification project (CREP). As line pairs are electrified, they will be joined for through operations using the Rail Link. When enough service is operating through the two-track tunnel so that it becomes saturated, it will be time to finish the additional tunneling, tracks, and fixtures left incomplete in Phase 1. The pace of the CREP is flexible and can be accelerated or decelerated as possible or necessary.

It is currently suggested that additional Phase 2 electrified services be developed in the following sequence:

- Beverly-Franklin (D Line)
- Newburyport-Framingham (E Line)
- North Wilmington-Needham (G Line)
- Rockport-Plymouth (C Line)
- Littleton-Middleboro (F Line)
- Extensions to Fitchburg and Worcester

It is probable that service levels will approach the operational capacity of the Phase 1 two-track Rail Link after creation of the Newburyport-Framingham service. After that point it will be necessary to expand the Rail Link to its ultimate four-track capacity.

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[2]More detail on the costs for tunnel and station construction are provided in the appendix on cost and schedule.

The costs of Phase 2 will consist primarily of the costs of electrifying more lines, and adding electric motive power, coaches, and suburban parking to handle increased demand. Rough estimates of these future MBTA capital costs are provided in Table 9.

Table 9
Rail Link Phase 2 Budget[3]
1999-2020

Component	Millions
Tunnel & Stations	$417
Surface Improvements	$897
Added MBTA Rolling Stock	$466
TOTAL	$1,780

The phasing logic is driven by the intent to maximize the transportation benefits that can be gained from any physical plant investment before making new investments. All services which would build upon the Northeast Corridor electrification will be developed before any other services. Once any mainline is electrified, all branches along that line will be tied into the electric network before another mainline is electrified. Within the tunnel, it is possible to defer a portion of the costs of the third and the fourth tracks and make the best possible use of the two tracks before buying more capacity. The two longest lines (Worcester and Fitchburg) will be handled in two phases, with an earlier electrification of inner service and a later electrification of the outer zones.

Looking to the More Distant Future - After Phase 2, more than 20 years from now, it is very possible that this overall plan will have been accelerated, decelerated, or realigned. It is also very likely that extensions of regional rail service to new locations in New England will have been accomplished including: New Bedford, Fall River, Falmouth/Hyannis, Medway, Millis, Nashua, Dover or Portsmouth. The Rail Link facility will provide the capacity in surface terminals (North and South Stations) for these extensions to be operated as diesel services until they can be included on the CREP agenda and eventually operated as through regional services on the four track Rail Link.

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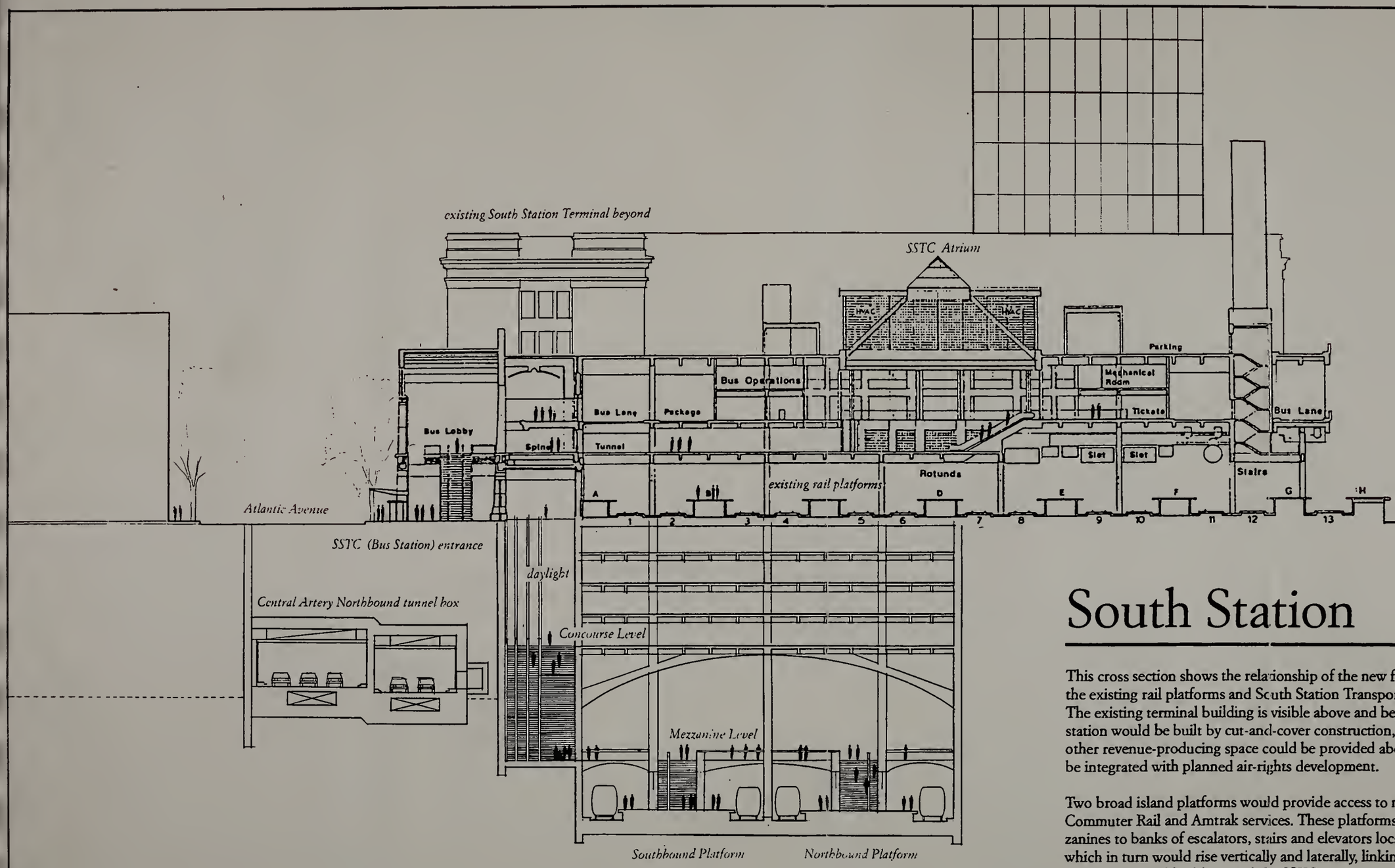
[3]Approximately $417 million will be required to expand the tunnel and downtown stations to four track capacity. An additional $600 million, plus an estimated $200 million for clearance adjustments, will be required to electrify 425 remaining track miles. Parking for the additional 13,000 riders will add $97 million. Electrifying the balance of the locomotive fleet will require an additional $336 million. Acquiring coaches to accommodate the additional 13,000 riders will require an additional $130 million.

Appendix

Figure A-1



Transverse Section

0 20' 40' 60' 80' 100'

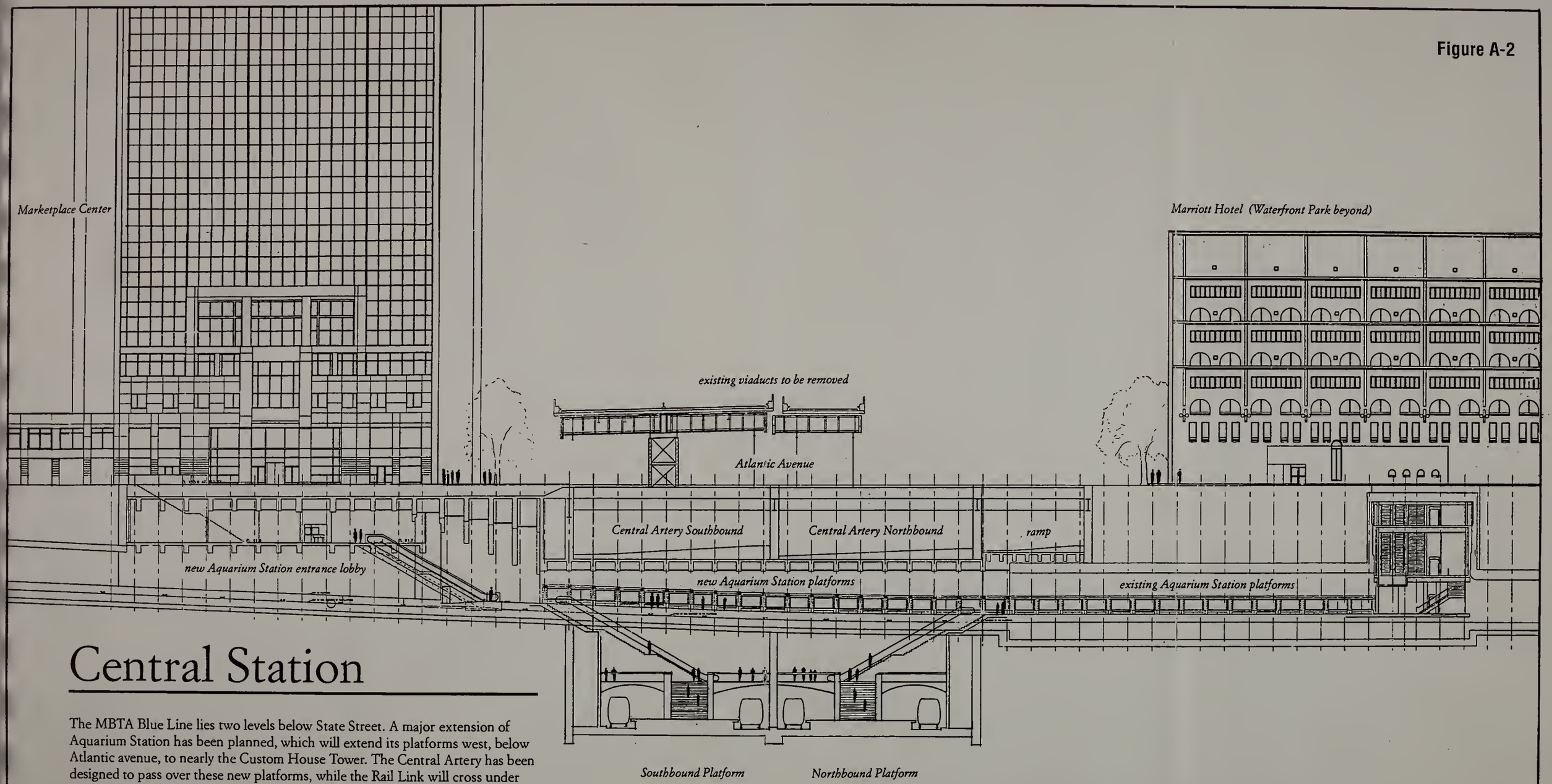
South Station

This cross section shows the relationship of the new four-track Rail Link station to the existing rail platforms and South Station Transportation Center (SSTC) above. The existing terminal building is visible above and beyond the SSTC. Because the station would be built by cut-and-cover construction, several levels of parking or other revenue-producing space could be provided above the station, which could be integrated with planned air-rights development.

Two broad island platforms would provide access to north and south bound Commuter Rail and Amtrak services. These platforms would be connected by mezzanines to banks of escalators, stairs and elevators located along Atlantic Avenue, which in turn would rise vertically and laterally, linking the new station to both the existing terminal building, and the SSTC.

An intermediate concourse about four levels below grade could receive natural light, mitigating the apparent depth of the station. A moving sidewalk could also be provided at this level for enhanced access to the Red Line, Transitway, and terminal building.

Figure A-2



Central Station

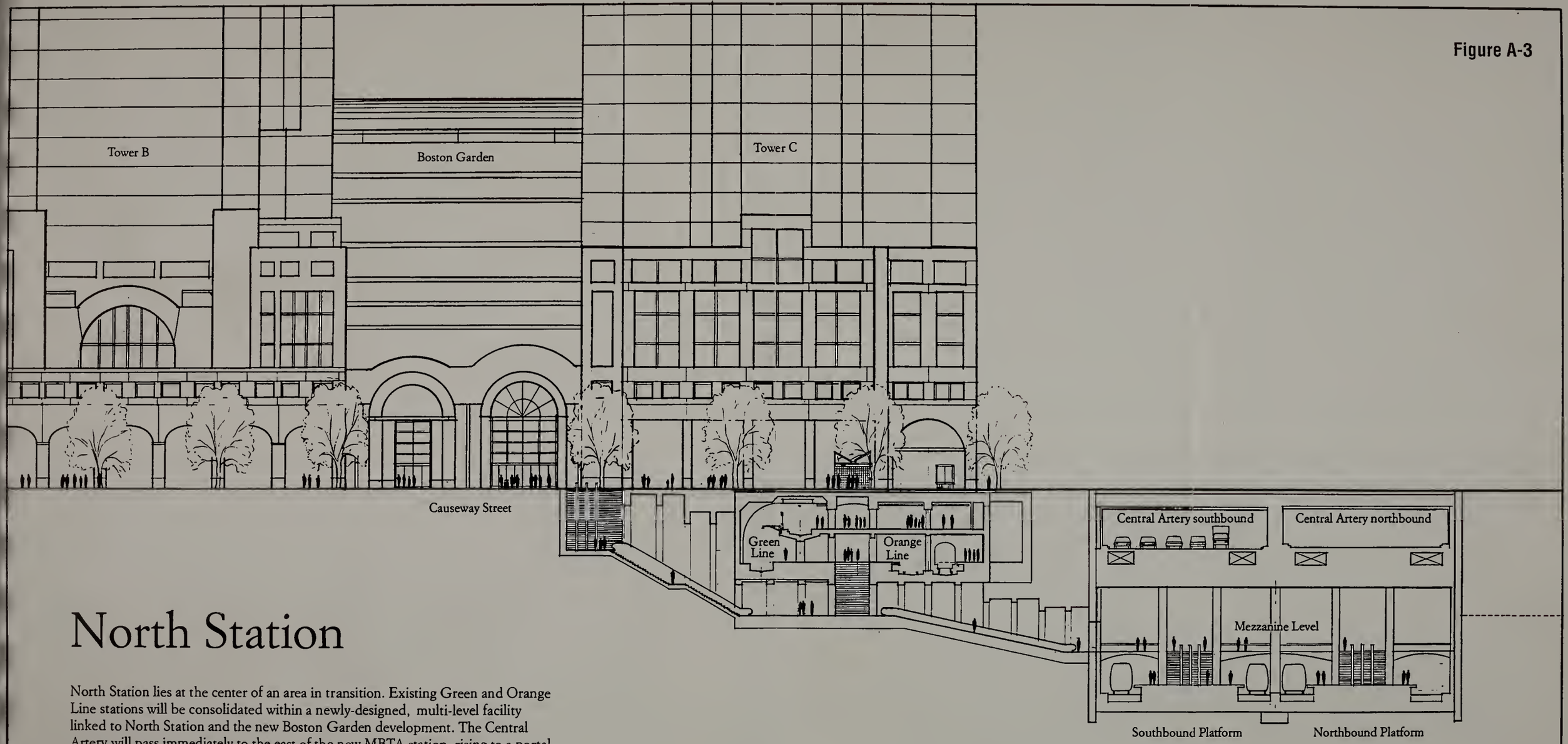
The MBTA Blue Line lies two levels below State Street. A major extension of Aquarium Station has been planned, which will extend its platforms west, below Atlantic avenue, to nearly the Custom House Tower. The Central Artery has been designed to pass over these new platforms, while the Rail Link will cross under them. In this cross section, the *existing* Aquarium Station and Marriott Hotel are at the right; Marketplace Center and the new Aquarium Station lobby are at the left.

The new Central Station of the Rail Link will provide 800' Commuter Rail platforms extending from State Street to Broad Street. At their northern end these platforms will connect directly to the Blue Line and surface destinations adjacent to Quincy Market. To the south, these platforms will serve International Place, Rowe's Wharf, and the Financial District.

Transverse Section

0 20' 40' 60' 80' 100'

Figure A-3



North Station

North Station lies at the center of an area in transition. Existing Green and Orange Line stations will be consolidated within a newly-designed, multi-level facility linked to North Station and the new Boston Garden development. The Central Artery will pass immediately to the east of the new MBTA station, rising to a portal just north of Causeway Street.

This cross-section shows the excellent connectivity to the Orange and Green Lines which a new Rail Link station built below the Artery tunnel box would enjoy . Both ends of the new MBTA station could be linked by banks of escalators to mezzanines serving the new Amtrak and Commuter Rail platforms below. Projected development at Boston Garden and in Bulfinch Triangle generally would also benefit substantially from the area's first direct linkage to the southern Commuter Rail and Amtrak Northeast Corridor services.

Transverse Section

0 20' 40' 60' 80' 100'

Figure 1
Central Artery Rail Link Route
1.5" = 1000'